

AN EXPERIMENTAL INVESTIGATION ON THE EFFECTS OF WEB-BASED
INSTRUCTION/TRAINING ON COGNITIVE AND
PSYCHOMOTOR LEARNING

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The purpose of this study was to investigate the effects of web-based instruction (WBI) on cognitive and psychomotor learning. The subjects of the study received two types of instructional methods, WBI (experimental group) and traditional classroom instruction (control group). Each group received 30 minutes of instruction on “Soldering a Circuit Board.” The researcher chose this content subject because it involved both cognitive and psychomotor objectives, which suited the purpose of this study. It was hypothesized that there would be no significant difference between the two methods of instruction, and also that there would be no significant interaction effects between methods of instruction and gender.

Forty-six subjects from a population of students enrolled in summer classes offered by the Applied Technology, Training and Development (ATTD) program at the University of North Texas voluntarily participated in this study. Random assignment of subjects was applied in this study. A subject matter expert delivered the content for both the experimental and control groups. To measure cognitive variable, a 10 item, multiple-choice test was administered immediately after instruction. To measure the psychomotor variable, a 15-item checklist was utilized by trained judges to evaluate learners’ performances while soldering. The 2 x 2 factorial model with interaction was used in this

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TABLE OF CONTENTS

	Page
LIST OF TABLES	vi
LIST OF ILLUSTRATIONS	viii
Chapter	
1. INTRODUCTION	1
Background and History	4
Need for the Study	8
Theoretical Framework	9
Purpose of the Study	11
Statement of the Problem	11
Research Hypotheses	12
Delimitations	12
Limitations	13
Definition of Terms	14
Summary	17
2. REVIEW OF THE RELATED LITERATURE	19
Instructional Technology and Distance Learning	19
WBI versus Traditional Classroom Instruction	26
Learning Domains	46
Principles of adult Learning	55
Gender Issues with Online Learning	63
Summary	64
3. METHODS AND PROCEDURES	66
Population	66
Sample	68
Ethical Standard	67
Research Design	67
Instructional Material	70
Instructional Treatments	72
Pilot Study	78

Data Collection Procedure	80
Instrumentation	81
Data Analysis	86
Hypotheses Discussion	87
Summary	89
4. FINDINGS	91
Data Description	92
Statistical Analysis	102
Hypotheses Testing	109
Summary	115
5. SUMMARY, DISCUSSION, CONCLUSIONS, AND	
RECOMMENDATIONS	116
Summary	116
Discussion of Findings	118
Conclusions	125
Recommendations	127
APPENDIXES	131
Appendix A: Table of Sample Size	132
Appendix B: Institutional Review Board Approval	134
Appendix C: Research Consent Form	136
Appendix D: Sample Size Requirements	141
Appendix E: Traditional Classroom Instruction Materials	143
Appendix F: Web Based Instruction Materials	145
Appendix G: Instructor's Resume	174
Appendix H: Teaching Agreement and Conditions	177
Appendix I: Memo for Instructors in ATTD Programs	179
Appendix J: Knowledge Based Test	181
Appendix K: Checklist Form	183
Appendix L: Demographic data collection form	186
REFERENCES	188

LIST OF TABLES

Table

1. Instructional Development Phases of Traditional Classroom	
Instruction and WBI.....	26
2. Summary of the Differences Between Traditional Classroom	
Instruction and WBI.....	27
3. The Ability of Four Types of WBI to Deliver Cognitive Skills.....	51
4. Sample Size Requirements	70
5. Summary of the Reliability Coefficients for Each of the	
Performance Measures	93
6. Fields of Study of Subjects.....	94
7. Educational Level of Subjects	95
8. Age of Subjects	95
9. Gender of Subjects	96
10. Previous Experience With Soldering a Circuit Board.....	97
11. Number of Subjects in Each Method of Instruction.....	98
12. Means, Standard Deviations, and Frequencies of Scores of	
Subjects in Cognitive Learning	100
13. Means, Standard Deviations, and Frequencies of Scores of	
Subjects in Psychomotor Learning	102

14. Summary ANOVA for Cognitive Learning	104
15. Summary ANOVA for Psychomotor Learning.....	105
16. Power and ES Calculations for Treatment Effects in Cognitive Learning.....	108
17. Power and ES Calculations for Treatment Effects in Psychomotor Learning	109
18. Summary of Hypotheses Testing.....	115

LIST OF ILLUSTRATIONS

Figure

1. Interrelation of learning domains	5
2. Web-based testing example.....	30
3. Web-based training sample	36
4. Levels of cognitive domain	48
5. Levels of psychomotor domain	52
6. Posttest only control group design	68
7. Circuit board kit.....	74
8. Distribution of subjects' scores on cognitive learning	99
9. Distribution of subjects' scores on psychomotor learning	101
10. Measure of association formula.....	106
11. Interaction effects in cognitive learning	111
12. Comparison of mean scores (method) in psychomotor learning.....	112
13. Interaction effects in psychomotor learning	114

CHAPTER 1

INTRODUCTION

The advent of advanced technology and the dramatic explosion of Internet users have provided a new avenue for instructional delivery. The U.S. Commerce Department announced that Internet traffic is doubling every 100 days (Abernathy, 1999a). Web-based instruction (WBI) usage has increased greatly over the last few years. While traditional classroom instruction still retains an important place in learning, WBI allows training and teaching to be continued anywhere and at anytime. For example, a study of the Web-course conversion project in Oak Ridge, Tennessee started in January 1997 with one course. By April 1998, more than 50 courses were available. Now, the project has developed 10,899 web-based courses (Schriver and Giles, 1999). The return on investment on this conversion was \$1,690,519.50 (p. 52). This study indicates that every dollar spent on a WBI course is worth nine dollars spent on the traditional method of delivery. The biggest saving comes from participants' travel time and instructor time (p.52). WBI learners, unlike other methods of delivery, can receive fast and updated information about a given subject matter. Along with the removal of geographic restrictions, WBI has been shown to be cost-effective (p.52).

The trend toward digitization of knowledge accelerates the movement from campus-based learning to web-based distance education. This inevitable result impacts adult education in our society and in the work place (Leonard, 1999). Web-based

instruction can support adult learning. McIntyre (1997) concludes that the use of the web as a learning tool meets the requirements of adults. Zemke, (1998) and Knowles et al. (1998) agree that adults prefer self-directed learning to any other learning style. They can use the web to seek out knowledge and acquire skills on their own.

WBI programs can be easily delivered to the learners in an individualized manner. Based on the person's preferred learning style, a smart WBI system can look into the user's eyes and determine the best way for presenting the information that the user is ready for. WBI programs reduce the instructional time to teach competencies that the learners have already demonstrated. Furthermore, as some studies show, the time for mastering an objective is reduced by using multimedia and interactive computer programs. For example, it may roughly take a learner 50% of his/her time to acquire a certain skill by using multimedia programs rather than traditional media.

WBI, when incorporated with multimedia, can be very valuable for training in dangerous or inaccessible environments. For example, during the Desert Storm War in the Persian Gulf in 1991, military tank drivers received much of their training by using a multimedia simulator that "exhibits not only realistic animated visual stimuli, but also other conditions, including sounds, vibrations, and the intense heat that can be build up inside a tank" (Hix & Hartson, 1993, p.37). In terms of testing and evaluation, WBI programs test the users' abilities of accomplishing particular tasks. Well-designed WBI programs can test the level of understanding and even provide logical questioning techniques to assess someone's understanding of the subject matter.

Delivering instruction by using various types of multimedia application, such as books, video, audio, computer-based instruction, and web-based instruction engages adults in the learning process (McGee, 1998). Many studies support that adult learning is not reduced as a result of receiving instruction via distance learning. Ashe and Buell (1998) present findings in other studies that show no difference in the level of achievement between distance-education learners and traditional learners. In addition, they describe the characteristics of distance-education learners as job seekers, adults, and professionals. These learners tend to gain knowledge that can be applied in their daily lives or in their jobs. Also, they have a desire for learning by doing and obtaining instructor comments.

Barron (1999) highlights the importance of WBI as a current trend of online learning and delivery. Many organizations have moved toward trend of WBI, which is usually referred to in the corporate environment as a Web-based training. Web-based training takes two forms: asynchronous and synchronous systems. Asynchronous systems do not require a live interaction between the learners and the instructor. They can interact through email or use of a bulletin board. The learners and the instructor can discuss issues and ask questions regarding the related course of study. Asynchronous web-based learning, which has been commonly used, falls short in engaging the learners (Derringer, 1999). Synchronous systems, on the other hand, require two-way interaction between the instructor and the learners and among the learners themselves (Barron, 1999). “For many organizations, synchronous, two-way interactivity, is considered a mandatory component of online learning” (Barron, 1999, p.30). Consequently, many educators are researching

the effects of using synchronous systems on achieving learning objectives. This research study attempts to find the effects of using synchronous learning since many organizations, colleges, and universities are moving rapidly toward the use of WBI programs.

Background and History

Learning Domains

Benjamin Bloom (1954) defined three domains of educational objectives. They are cognitive (knowledge), psychomotor (skill), and affective (attitude). In 1948 at the American Psychological Association Convention in Boston, Bloom and his colleagues discussed the difficulties of cooperating and communicating about educational objectives and evaluations of the learning process. They arrived at a conclusion that “educational objectives are to give direction to the learning process and to determine the nature of the evidence to be used in appraising effects of learning experiences, the terminology must become clear and meaningful” (p.4). Therefore, they have devised a taxonomy that classifies the educational objectives into three major domains: cognitive, psychomotor, and affective domain (Bloom, Engelhart, Furst, Hill, and Krathwohl, 1954).

Categorizing the learning types as cognitive, psychomotor, and affective does not mean that they are mutually exclusive (Henke, 1997). This means that if one learning domain occurs, one or the two other domains may exist. Figure 1 illustrates the relationships among the three domains of learning.

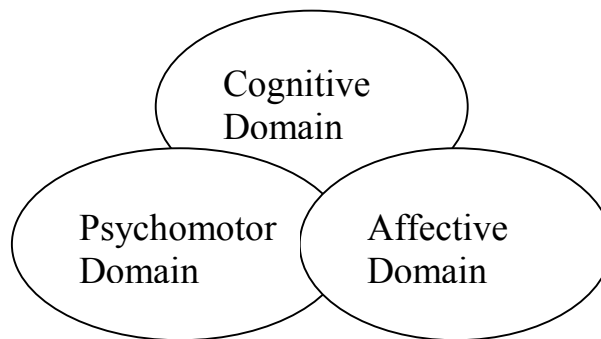


Figure 1. Interrelation of learning domains.

Schwaller and Kemp (Henke, 1997) provide support to this premise in that even though technology involves at the beginning cognitive learning, it enhances learning in the other domains. Although cognitive and psychomotor domains overlap, the relationships between the cognitive and psychomotor domains are too low to predict one type of response from the other (Bloom, Krathwohl, & Masia, 1964). For example, individuals with high computer software achievement do not necessarily have high skills in dealing with computer hardware. Therefore, each of these domains needs to be examined independently to make correct conclusions of the learning process.

Bloom's definition has a significant impact on the field of training and development. All of these domains, if they were carefully considered in the training program, would ensure the success of the curriculum development in that program. The curriculum will be relevant to the learners' needs and culture. Therefore, the learning process will be simple and dynamic.

Web-based Instruction

Khan (Wu, 1998) defines WBI as an innovative approach for delivering instruction to audience at distance utilizing the web as the medium. It is a hypermedia-based program that utilizes the attributes and resources of the WWW to create a positive learning environment. Enough resources, appropriate multimedia elements, adhering to the user-interface design guidelines, and suitable activities must be available when designing WBI course (Wu, 1998). Rada (1998) referred to WBI as a web-based training, which is a subset of Internet-based training and one of the newest forms of distance learning.

While traditional classroom instruction is still the most popular method of teaching and training, according to a survey results conducted by McGee (1998), many companies and educational institutions are moving rapidly toward WBI. It is the newest and the most adopted instructional method in the training and education fields. WBI outperforms traditional classrooms by providing a uniform, technology-based format. It provides simultaneous instructional delivery (training). All learners can receive instruction in the same time and in an individualized manner. Therefore, organizations are increasingly relying on web-based instruction as a solution to issues of immediacy, convenience, and consistency (Colbrunn & Tiem, 2000).

Statistics and Numbers

Although instructor-led classroom remain at the top as the most utilized mean for learning and training with an 81% usage, web-based instruction is increasing. Fifty percent of organizations with a hundred or more employees use Internet-based training.

Although only 13% devoted complete web-based training, the numbers indicate that this method of training is moving up rapidly, since it was only 6% in 1996 (Lorinzo, 1999). A recent survey conducted by Training magazine reveals that 33% of training programs use web-based training (Hoekman, 1999). The American Society of Training and Development indicates that the percentage of traditional instructor-led classroom training is decreasing while the percentage of web-based instruction is increasing (Keats, Floyd, and Goldsberry, 1999). In 1998, the usage of instructor-led classroom accounts for 67% of all forms of instructions. However, in 2002, the expected percentage for instructor-led classroom usage will account only for 38%, web-based instruction will also account for another 38%, and other forms of instruction will use the remaining 24% (Keats et al., 1999).

According to Internet research firm International Data Corp, companies spent \$100 million on Internet-based training in 1998 (Bechard, 1999). That figure is expected to reach \$6 billion by 2002. Abernathy (1999b) compares this figure to the figures in 1997, and concludes that the compound growth rate of using web-based training is approximately 95% from 1997 to 2002. This huge increase in web-based instruction usage relates to the fact that adults have the tendency to learn via the web, rather than relying solely on instructor-led instruction (Bechard, 1999).

Many corporate and educational institutions in the late 1990's have shown a rapid movement toward web-based learning programs (DeLima, 1999). For example, seven web-based courses were developed at the University of North Texas for the Summer of 1999. In the 1999 Fall semester, there were thirty one web-based courses, and thirty eight

web-based courses is offered in the Spring 2000 (UNT web-based courses, 2000). Noticeably, these statistics support the fact that universities and colleges as well as corporate training programs are moving rapidly toward WBI. The question that these programs are encountering is: Are these learning experiences (web-based instruction) forthcoming?

Need for the Study

Studying the effects of Web-Based Instruction in the field of applied technology, training and development is necessary. The field lacks studies that measure the effectiveness of Web-based Instruction on delivering cognitive and psychomotor learning. Educators are currently experiencing an explosion of Web-based instructional systems. The Web has suddenly become the de-facto, global technology platform for instruction and learning. Although Web-based instruction is the fastest growing area of educational technology research, little has been known about how to effectively design and implement these systems for educational applications (Romiszowski, 1997).

The effects of this method of delivery need to be examined based on the needs of adult learners. Furthermore, adult learners have special characteristics that differ from children or adolescents. They have the characteristic of being self-directed learners (Craig, 1996; Driscoll, 1998; Piskusrich, 1993). Therefore, WBI can impact adult learning in various ways.

Web-based learning will impact both the field of training and development and the field of educational technology. Jones and Paolucci (1997) estimate that less than 5% of published research is sufficiently empirical, quantitative and valid to support

conclusions with respect to the effectiveness of technology in educational learning outcomes. They argue that the influence of technology, while substantial, is largely unfounded and serious consequences may result if there is a sustained limited delivery of the uses of technology by instructors. They question the untested educational quality of technology, resulting from relatively unproven paradigms and the questionable cost benefit associated with this continuance. Their conclusion was a call for further research concentrating the application of appropriate technologies to the learning outcomes of the subject matter to which technology is applied. The research in this dissertation adds focus to the theme of Jones and Paolucci's argument. While substantial research exists which identifies components of various teaching/learning models, few suggestions have been made to measure the effects of web-based instruction on cognitive and psychomotor learning (Paolucci, 1998). Combined research on how technology helps cognitive and psychomotor learning would assist organizations and educational institutions become aware of the level of performance of their learners during a course of instruction. Many managers in the corporate arena believe that WBI is the future of their training programs (Barron, 1999). This method of instruction "is not a fad, and it is not for the lazy" (Abernathy, 1999b, p.36). Therefore, research and studies need to be conducted to measure the effectiveness of WBI on the cognitive and psychomotor domains of learning as defined by Bloom (1954).

Theoretical Framework

Using theory as a guiding framework to build on the work of others allows research to be replicated and enhances its generalize-ability and meaningfulness

(Merisotis & Phipps, 1999). A review of the literature on web-based instruction yields several theoretical approaches for delivering courses or units of instruction. Bloom (1954) classification of learning domains, Harrow (1972) taxonomy of the psychomotor domain, and adult learning theory (Knowles, Holton, & Swanson, 1998) principles provide guidance for the selection of a theoretical approach for delivering instructional objectives via the web. Because “media have an important and unique role to play in instruction” (Tennyson, Schott, & Dijkstra, 1997, p.322), Web-based instruction has the ability to facilitate the development of knowledge structures that support flexible classes of performance, in certain domains of interest.

The ability to provide learning in two or more domains is a crucial aspect of web-based instructions. Driscoll (1998) theorizes that cognitive skills that involve solving problems, applying rules, and distinguishing among items are best suited for web-based training. However, she argues the inappropriateness of delivering psychomotor skills on the web as a stand-alone medium. Web-based training can be an appropriate method of instruction when there is a “gap in learners’ skills, need for cognitive skills, learners have adequate computer skills, and organization has capacity to deliver” (Driscoll, 1998, p.2). Using the web to repeatedly demonstrate a psychomotor task that requires expensive use of materials saves time and money compared with showing the same task repeatedly in a traditional classroom setting (Henke, 1997).

This study examined and compared two methods of instruction (traditional instruction versus web-based instruction). The study attempted to provide evidence that WBI is an effective method of delivery for both cognitive and psychomotor learning.

Purpose of the Study

The purpose of this study was to measure the effects of web-based instruction on cognitive and psychomotor learning. This study examined the usefulness of using WBI in conducting cognitive and psychomotor training. In addition, the study utilized the graduate and the undergraduate students (adult learners) who were enrolled in summer courses offered by the Applied Technology, Training and Development program at the department of Technology and Cognition at the University of North Texas. The participants received a 30-minute instructional session in order to measure their ability to acquire cognitive and psychomotor objectives. Two methods of instruction were compared: web-based instruction and traditional methods of instruction. The participants were divided into two groups: one group received instruction via the web (experiment group) while the other group received traditional instruction (control group). The study also investigated the interaction effects of gender and methods of instruction on cognitive and psychomotor learning.

Statement of the Problem

The non-traditional method of instruction, web-based instruction (WBI), sometimes involves two-way audio, video, and textual interactive learning. The kind of media used and the level of interaction vary based on the nature of the given course. The problem that this study investigated was the need for evidence that this new method of instruction is as an effective instructional method, especially for delivering cognitive and psychomotor learning, when compared to the traditional method of instruction, where the instructor and students are in the same room at the same time. The future of educational

and corporate institutions depends on their willingness and ability to change as technology changes. Otherwise, they may not survive the next wave of change brought about by further advancements in communication technologies. The use of WBI requires redefinition of the roles of educators and trainers so that a better learning environment can emerge.

Research Hypotheses

1. Adult learners' performance on cognitive objectives delivered via WBI is not significantly different from traditional methods of instruction.
2. There is no significant interaction effect between gender and method of instruction (WBI versus traditional methods of instruction) on cognitive objectives.
3. Adult learners' performance on psychomotor objectives delivered via WBI is not significantly different from traditional methods of instruction.
4. There is no significant interaction effect between gender and method of instruction (WBI versus traditional methods of instruction) on psychomotor objectives.

Delimitations

1. The study was limited to the graduate and undergraduate students in the Applied Technology, Training and Development program at the University of North Texas. The study will utilize the graduate and undergraduate courses offered in the program of Applied Technology, Training and Development (ATTD) to deliver a 30-minute instructional session for the purpose of this study.

2. The study was limited to soldering task. This task was chosen for two reasons. It is considered relatively new to the defined population in this study. Also, it involves cognitive and psychomotor activities, which were needed to conduct this study. Using a small segment of a course in order to be able to assess students' learning through a WBI course was recommended by Wu (1998).
3. The study was limited to the use of synchronous systems, which provide two-way interactive learning. The asynchronous systems, in contrast, were not included in this study due to their lack of live interactivity. The study delivered a 30-minute instructional session by using WebCT software. This software was considered the main web-based delivery system that was used at the University of North Texas and many other institutions in the United States. Many graduate and undergraduate courses at the University of North Texas utilized the WebCT system for teaching and learning purposes. This system had the characteristic of being synchronous.

Limitations

1. The learners, the subjects of this study, were assumed to be familiar with the use of a computer and the Worldwide Web. They were assumed to have the basic knowledge and skills that enable them to access sites by using URLs, send and receive emails, use the FTP applications, print out information from the Internet, and chat online.
2. Subjects were not pretested for soldering ability; rather, the determination of the lack of previous soldering experience was made by a use of a questionnaire.

3. Although the target population of this study was the graduate and undergraduate students who were enrolled in the program of ATTD in the College of Education at the University of North Texas, the sampling selection procedure was limited to those students who volunteered for the study.

Definition of Terms

For the purpose of this study, a brief description of the key terms is provided.

A motor skill: is any muscular task or activity, which is directed to a specific objective (Kerr, 1982). The objective of the psychomotor or motor skills in this research was to solder a circuit board using soldering iron and other associated materials.

Adult learners: is a type of learners who are usually characterized as 18 years old and older. Adult learners have special needs that must be comprehend and accommodated by trainers as well as instructors (Craig, 1996). Knowles et al. (1998) describe this type of learners as self-directed learners, who have special needs and seek out to meet these needs.

Asynchronous system: is a type of communication systems that does not require both the instructor and the learner to communicate at the same time. In fact, asynchronous systems are more used in the training environment than synchronous systems due to their availability and cost-effectiveness. A typical example of asynchronous systems is “e-mails.”

Cognitive domain: involves knowledge acquisition. Knowledge can be as simple as recall of information or as complex as synthesizing information and reaching conclusions.

Computer-based instruction (CBI): is a method of Instruction delivery that uses computer to deliver instructional programs according to the pace and characteristics of the learner. The learner can access the training course at his/her convenient, whenever is needed (Piskurich, 1993). In the corporate world, this method of instruction is referred to as a computer-based training (CBT); in which training materials can also be disseminated.

Computer-mediated communication (CMC): involves using the computers tools for communicating with other individuals who also use computer to receive or send messages.

Control group: the group of clustery selected students who do not receive web-based instruction/training. In fact, it is the group that is exposed to traditional classroom instruction.

Distance learning: The United States Distance Learning Association (2000) defines distance learning as the acquisition of knowledge and skills through mediated information and instruction, encompassing all technological and other forms of learning at a distance. The terms distance learning and distance education are often interchanged but this is considered by many to be inaccurate. Distance learning is really a result of distance education since it is the student who is responsible for learning while the instructor controls the delivery of the materials.

Experimental design: adopting one of the true experimental designs to measure the effects of a treatment on the dependent variable by comparing it to a control group.

Experimental group (Treatment Group): the group of clusterly selected students who received instruction on the web.

Intranet: is similar to the Internet in terms of information accesses and processes. However, Intranet is small network that allows individuals in a company to share information and exchange ideas, and at the same time prohibiting illegible access from outside people.

Learning: “is a relatively permanent change in performance resulting from practice or past experience” (Kerr, 1982, p.5). Subjects in this study were assumed to leave the provided training session with a change in their performance regarding soldering a circuit board.

Performance: is a periodic occurrence fluctuating from time to time. It is transitory (Kerr, 1982). Subjects in this research were tested on their ability to perform soldering task.

Psychomotor domain: is concerned with the use and the acquisition of motor or muscular skills. In this study, using soldering iron to solder a circuit board simulates psychomotor learning.

Synchronous system: is a type of communication systems that requires both the instructor and the learner to have a live, interactive communication. A typical example of synchronous systems is “chat-rooms.”

Traditional classroom instruction: involves the students and instructor who are in the same room at the same time in a face-to-face interaction during instruction. It is also called instructor-led classroom.

Web-based instruction (WBI): is defined as a method of delivery in which instruction can be delivered over the Internet or over a company's Intranet. Using a web browser, such as Microsoft explorer or Netscape navigator, allows for training access. Web-Based Instruction is interactive and utilizes the available multimedia to enhance the level of delivery of instruction (Hall, 1997). Web-based Instruction is referred to as web-based training (WBT), web-based learning, interactive distance learning, Intranet-based learning, or Internet based instruction (IBI) (McMasters, 1999). However, they all share the same concept, which is delivering learning to audiences at disparate locations using the Internet Infrastructure (Barron, 1999).

Summary

The future of the field of education and training will be greatly affected by delivering web-based instruction courses. This method of delivery will involve many challenges to WBI designers as well as the instructors who adopt this method. These challenges will not be limited to presenting the information on the web or providing interactive multimedia programs; rather, it will have impact on the instructional value of content. The challenge is to produce system that understands the user's way of gaining knowledge and skills. Then, the system needs to find an endless conversation in which the user is carefully and gradually brought to the point.

The remainder of this research study contained the literature review chapter, the methods and procedures chapter, the findings chapter, and the summary, conclusions, and recommendations chapter. The next chapter in this research is the literature review chapter. It investigated and synthesized the findings of previous studies and real-world

experiences related to this study. The third chapter of this research was the methodology chapter. This chapter included information about the population and sample of the study. The chapter also discussed the procedures and results of conducting a pilot study. The data collection procedure and the data analysis were important subdivisions of that chapter. The findings chapter, chapter four, presented the findings of the experiment conducted in this study in both narrative and tables format. The fifth chapter in this study, the summary, conclusions, and recommendations chapter, summarized the findings in this study. The researcher attempted to draw conclusions by connecting the results of the study with the related literature. At the end of this study, recommendations were provided based on the drawn conclusions.

CHAPTER 2

REVIEW OF THE RELATED LITERATURE

This chapter provides the theoretical and empirical basis for the consideration of delivering instruction on the web. The chapter will explore and synthesize educational studies and real-world experiences of using web-based instruction (WBI) in delivering training programs. A major theme of this chapter is analyzing and comparing the learning outcomes of WBI versus traditional classroom instruction. Also, the concept of adult learning will be one of the major subsections of this chapter. Therefore, this chapter consists of the following main sections: instructional technology and distance learning, web-based instruction versus traditional classroom instruction, learning domains, principles of adult learning, and gender issues with online learning.

Instructional Technology and Distance Learning

History

Distance learning has been defined as a situation where the learner and instructor use telecommunication devices that enable direct or indirect interaction between the instructor and the learners (Azarmsa, 1993). Distance learning was introduced in the late 1800's in the United States at the university of Chicago where the first major correspondence program was established in which the teacher and the learner were at different locations (McIsaac, 1998). Distance education has evolved into a heavy technological basis since those early correspondence courses.

The field of distance learning has seen three distinct generations of growth. Early correspondence courses are the first generation. These courses were done through written and printed material and sent through the postal service to the students. This process was very slow (Bitter & Pierson, 1999).

The real emergence of instructional technology began in the early 1960's. This is called the second generation, which perceived the advent of television broadcasts of classes and audiocassettes being distributed to students. Telephones were also used for student-teacher conferences with these technologies. The main pitfall of this generation is that instructional technology has been limited to delivering information (Bitter & Pierson, 1999). Television is one of the major examples for using technology in presenting educational knowledge, and that has been used in the educational field for decades. The traditional use of technology in few of our educational systems has been utilized to isolate the content or the message of the communication from the reality. Berge and Collins (2000) emphasizes the role of the distance education teachers on encouraging the learners to interact with the learning environment, not limiting themselves to the content of the given subject matter.

The third generation of the evolvement of distance learning is the integration of computers into the distance-learning model. This includes two-way interactive video and computer conferencing via chat rooms and email. The key with this generation is that it can be done both synchronously and asynchronously depending on the needs of the class and instructor. Therefore, this integration is surly going to lead to the emergent of new forms of learning (Bitter & Pierson, 1999).

Today, the educators encounter distance learning that is connected to the rapid development of computer-related technologies. Several studies that used distance-learning courses show that students learn better with the use of computer-mediated instruction while few others deny it. For example, a study by Martin and Rianey cited in McIsaac (1998) found that learners perform better with the use of video-conferencing than those who did not use it. The learner-driven model of education makes distance learning a better way for learning. Employees and adult learners need to retrain themselves by taking courses and seminars through distance learning programs. Now, this is practical in the US because of the availability of technology and online connections. According to McIsaac (1998), the mission of distance learning is to prepare children and adults to gain skills and enhance their knowledge in a way that affects their lives and the society, in which they live.

Effects of Distance Learning

Distance learning is not limited to delivering education. Rather, it enables learning; it allows for a more interactive, integrated learning environment. However, there are many issues to consider for integrating technology into our educational system so in order to have a dynamic distance learning system. Computer-mediated communication (CMC), such as e-mail or chat rooms, add new ways for organizing and designing distance learning courses. This notion requires both the teachers and the learners to change their views of distance education to become “distance learning”, in which the roles of the teachers and the students become facilitators and active learners, respectively. Furthermore, distance learning extends the role of the teachers to become

creators of an environment that motivates the learners to acquire specific skills and knowledge (Berge & Collins, 2000).

The evolution of distance learning programs will continue; indeed, distance learning is expanding instructional boundaries (Azarmsa, 1993). CMC allows for various types of interaction in addition to providing the students with the freedom to select the most comfortable, preferred learning styles. Thus, the new application of distance learning must drive the decisions for the use of technology. CMC instructors are capable of teaching multiple-intelligence by using various methods of instruction. For learners to fully interact through computer-mediated learning, instructors need to provide students with special skills and more sophisticated technical support (Merisotis and Phipps, 1999). Course design issues, resource allocation, activity selection, online structure, and evaluation planning are important considerations for CMC courses in distance learning. More importantly, the design phase of distance learning courses delivered via CMC should be based on a learner-center approach (Berge & Collins, 2000). This type of approach can meet immediate learning needs as well as help learners direct their own ongoing learning.

Ashe and Buell (1998) state that distance learning will affect the learning systems around the world. This type of learning is useful for different types of organizations, and it can enhance the learners' skills and knowledge at various ages and situations. They define distance learning as a process of learning that is distinguished from classroom learning by emphasizing the separation among the learners and between the learners and the teacher. Separation of time and location eliminates eye contact and nonverbal

communication. One of the most important points that Ashe and Buell (1998) address is utilizing new technological innovations (e.g. streaming video) make distance learning more successful by creating dialogue and structure among the learners. They suggest that distance learning can create rapport among the learners and between the learners and the instructor. In addition, using video technology as one of the distance learning methods of delivery allows instructor to create innovative courses based on the virtual classroom model. Traditional classroom instruction however, will not disappear, even though statistics support that the number of online courses is dramatically increasing; (Delima, 1999). Delima purports that web-based learning complements traditional learning. Therefore, distance learning can effectively replicate the traditional classroom experience for the learners while being much more cost-effective than other learning delivery methods.

Several research studies on the effectiveness of distance learning found no significant difference exists between traditional instruction methods and distance learning, especially when used in business, military training, and adult learning (Azarmsa, 1993). McIssac (1998) supports these findings by providing several examples of schools and colleges that teach through distance learning. Stanford University has more than 5000 engineering and computer science professionals enrolled in over 200 courses. These courses combine text, video with audio, and graphics. Thomas Edison State College allows adult learners to take online learning courses and earn a baccalaureate and associate degrees at distance. To illustrate the effectiveness of online learning,” 90% of Thomas Edison alumni continuing their education are admitted to their

first-choice graduate or professional schools, including Harvard, Indiana University, California State University, Rutgers, Villanova Law School, and Princeton, as well as many medical schools” (McIssac, 1998, p. 29).

Instructional technology effects student achievement. Barron and Orwig (1997) report the results of several empirical research studies that found significant positive effects of multimedia instruction on students’ achievement. A study conducted by Apple Computer, the National Science Foundation, and the National Alliance for restructuring education revealed that learners become more active and involved with the use of technology in learning. For example, positive attitudes toward learning are increased with the use of technology when compared with traditional methods of instruction (Barron and Orwig, 1997).

In contrast, other educators such as Clark, Collis, and Rockman, as cited in Barron and Orwig (1997), contend that technology alone is not determining factor in effective education. “The instructional methods must be based on learning principles” (p.6). Clark (1983) also does not believe that high-tech media has a power to influence the effectiveness of the learning process. Indeed, he made a statement to the educational community that “there is nothing intrinsic to technology that makes the slightest difference in student achievement”. He also adds "...media are still advocated for their ability to increase learning when research clearly indicates that such benefits are not forthcoming. Of course such conclusions are disseminated slowly and must compete with advertising budgets of the multi-million dollar industry which has a vested interest in selling these machines." Consequently, Clark and other theorists, such as Collis and

Rockman, as discussed in Barron and Orwig (1997), conclude that learning is a result of adequate instructional design and development, not from the medium used to deliver instruction.

Research Implications of Online and Distance Learning

The information revolution and the explosion of information technology around the globe have engendered research on online and distance learning. Merisotis and Phipps (1999) question the validity and quality of research findings that have been conducted in the field of distance learning. After analyzing a large amount of research findings, which Merisotis and Phipps (1999) found about 40% of these independent works of research resulted in no significant difference between distance learning and classroom-based instruction. These research examined 1) student achievement; 2) student attitudes; and 3) student satisfaction toward and perception of distance learning. Many research studies are limited to measuring the effects of specific type of learning, which intended to inform or educate, not to build distinct skills.

Many experimental studies suggest that students in distance learning programs perform as well as students in traditional classroom-based instruction (Merisotis & Phipps, 1999). Other studies show that online learning programs are perceived equally with traditional methods of instruction (O'Malley, 2000). However, Merisotis and Phipps (1999) point out some shortcomings of research in this area of learning. First, much of the research, especially experimental studies of distance learning, does not control for extraneous variables and therefore cannot show adequately cause and effect relationships. Second, most of the studies ignore the power of using random sample from a defined

population. Third, tests and instruments are being used regardless of their validity and reliability Fourth, (p.7).

WBI vs. Traditional Classroom Instruction

The phases used to develop a web-based instruction courses are similar to the development of traditional courses (Driscoll, 1998). Table 1 provides a comparison of the phases.

Table 1

Instructional Development Phases of Traditional Classroom Instruction and WBI

Phases	WBI	Traditional Classroom Instruction
Analysis	<ul style="list-style-type: none"> • Assess learners needs • Determine instructional objectives 	<ul style="list-style-type: none"> • Assess learners needs • Determine instructional objectives
Design	<ul style="list-style-type: none"> • Choose instructional strategies (IRC, Listserv, Email, audio/video streaming) 	<ul style="list-style-type: none"> • Choose instructional strategies (discussion, simulation, lecture, illustration, etc.)
Development	<ul style="list-style-type: none"> • Decide interactions, feedback loops, and information structure 	<ul style="list-style-type: none"> • Select learning activities (role play, case studies, job aids, etc.), supported media (transparencies, flow charts, real objects, etc.)
Implementation	<ul style="list-style-type: none"> • Create web-based instruction • Incorporate multimedia resources (animation, sound, video, etc.) 	<ul style="list-style-type: none"> • Write content, instructional materials, worksheets, tests, supported media (PowerPoint, transparencies, slides, etc.)
Evaluation	<ul style="list-style-type: none"> • Review functionality and usability interaction (human-computer interaction guidelines) • Conduct a pilot study 	<ul style="list-style-type: none"> • Review and revise materials at each step • Conduct a pilot study

The primary difference between WBI and traditional methods of instruction (instructor-led instruction) is that the former has the ability to bring together a geographically diverse class, while traditional methods of instruction are bound by geographical location. Moreover, traditional methods of instruction are fixed by time. WBI, however, does not require the learner to meet at certain time if it uses an asynchronous system. In a synchronous system WBI becomes like traditional instruction in term of time constraint. Another key difference is resource availability; WBI has the ability to use resources that are located on the web or corporate intranets, while traditional classrooms are bounded by limited number of resources (Driscoll, 1998).

Table 2 provides a summary of the differences between traditional instruction and WBI.

Table 2

Summary of the Differences Between Traditional Classroom Instruction and WBI

	WBI		Traditional Classroom Instruction
	<u>Synchronous</u>	<u>Asynchronous</u>	
Location	Geographically open	Geographically open	Geographically bound
Time	Independent of time	Fixed of time	Fixed in time
Resources	Vast resources	Vast Resources	Resources limited

O'Malley (2000) conducted a study on students perceptions of distance learning, online learning, and the traditional classroom learning. After surveying 128 graduate and

undergraduate students, he found that students perceive online learning as more effective method of teaching than conventional distance learning. However, when online learning was compared with traditional methods of instruction, students prefer traditional instruction to online learning (O'Malley, 2000).

Advantages

Modern classrooms have integrated CD-ROM training programs into their curriculum. Therefore, it is necessary first to compare CD-ROM instruction to WBI. Fister (1998) points out the importance of web-based training in the life of today's organizations by comparing the use of web-based training to the use of CD-ROMS, which is a typical method of delivery for computer-based training programs. Web-based training can still be interactive, self-paced, and in time, but the cost is much less expensive than a CD-ROM course. In addition, web-based training course development is often simple to design, unlike CD-ROM development. Updating web-based training courses can be much less expensive than any other method of delivery. For example, for an instructor to make alterations or replace outdated materials, he/she must return to the manufacture and wait for an update. In contrast, WBI designer can make immediate changes by accessing an HTML editor from any remote location. Schriver and Giles (1999) ensure that delivering courses on the web or a company's Intranet can generate revenue and still provide adequate training. Furthermore, Heinich, Molenda, Russell, and Smaldino (1999) contend that the major advantage of web-based instruction is the low cost. They ensure that the costs of hardware, software, and telecommunication services of the web are nominal and decreasing. In the meantime, instructor-led courses were

becoming extremely expensive (Torode, 1999). For instance, designing a CD-ROM training program costs about \$500,000 dollars (Fister, 1998, p. 43). Consequently, many organizations are turning away from traditional methods of instruction because of the enormous loss of time and resources necessary to pay for classes and the decrease in productivity of their employees (Torode, 1999).

Furthermore, saving time is another major factor that leads companies and educational institutions to move towards web-based instruction. McMasters (1999) ensures that in addition to saving money, WBI can reduce instructor and learners' time of accessing and obtaining immediate feedback. WBI has the ability to provide just-in-time information. Companies can apply this approach by accessing courses that are offered in universities and colleges based upon the specific needs of their employees. Bechard (1999) prefers this approach of learning and training because it helps the employees translate their new knowledge and skills into practice. In Bechard's point of view, learning will be more flexible and customizable with the use of WBI.

Moreover, WBI, unlike traditional classroom instruction, helps participants seek out knowledge for the questions encountered during their interaction with the instructor or other colleagues. By providing links to other related sites. If the instructional course lacks important information or the student desires additional knowledge, links can fulfill such needs. Another benefit of links on the web is that they offer different perspective on related topics. Indeed, this unique feature makes the web a tremendous learning environment for the fields of both education and training. Hayes (1999) mentions, “ a

unique feature of web-based training is the ability to link to any other material on the web” (p. 111).

Another major advantage of WBI programs over alternative forms of training is the inclusion of testing (Hall, 1997). Figure 2, a quiz on principles of gas-fired furnaces that is given by Strategic Solutions Group (2000), illustrates testing on the web.



Figure 2. A web-based testing example.

Web based testing can be as effective as testing in a traditional classroom environment. The test question represented by Figure 2 is easy to read, and the directions are clearly presented. After answering the question, the learner can click on NEXT to complete all the items in the test. After completing the test, the learner can simply submit it to either the computer or the instructor to be graded. The learner can receive immediate feedback about the test as is the case in the WebCT system. Web-based testing is a cost-effective and efficient method in comparison to written test or other more common alternatives.

Waters (1999) presents several approaches for producing and delivering tests and ensuring their security. One approach of testing over the web is using an HTML (Hypertext Markup Language) format. This approach lends itself conveniently to the preparation of different types of test items for online, and even traditional, delivery. Another approach for web-based testing and security is to have monitors at a remote locations (Waters, 1999). Monitors are available to oversee the testing process and overcome technical difficulties. Best of all, using adequate testing software would eliminate problems with encryption and ensure a reliable scoring system (Hall, 1997).

Limitations

Web-based course design, as with any other type of instructional design, has some considerations and limitations that should be studied carefully during the development phase. The major drawback of using web-based courses is that they are not effective with the use of high-level multimedia. For example, streamed video can be choppy and may not contribute well to the learning process. Although technology is improving, WBI is not completely viable for video because it is limited by bandwidth constraints (Hoekman, 1999). Hayes (1999) states, “While we would like to use more video, audio, and animation, today’s available bandwidth makes downloads too slow for practical use of these technologies. Furthermore, there are too many competing technologies for the delivery of these services to make training universal” (p. 111). In order to sidestep those difficulties, designers should attempt to avoid using high-level multimedia if the same goal could be achieved with lower level multimedia, such as images (Fister, 1998). The use of videos, animations, or sounds does not necessarily assure that the design will

accomplish its objectives. Indeed, some designs that involved the use of complex and complicated multimedia failed to satisfy the learners' needs.

A budget shortage is not a significant problem with WBI; even with a budget of \$100, a course can be built (p. 43). In contrast, Keats et al. (1999) insists that the baseline costs for building a web-based Internet/Intranet program, depending upon graphics, animation, video and audio, range from \$30,000 to \$65,000. Simple WBI design consideration can substantially reduce the costs estimated by Keats et al. (1999). During the draft stages of WBI design, preparing a list of all media elements, even text, to be included is a useful technique. After listing these elements, designers should carefully consider each media element, and decide whether it can be accomplished with other types of media elements. If the use of video can be replaced with the use of images, for example, it is less difficult to do so; generally, the designer should make sure that the use of video is beneficial. Low budget alternatives to audio and video are sometimes more attractive and engaging. The use of web-based training should be interactive, so that the learners can get appropriate feedback as needed (Fister, 1998).

The learning environment of traditional classrooms is considered superior to those of WBI. Hoekman (1999) explains that employees receiving web-based training at their desks are more likely to be interrupted by others. To overcome this problem, managers should maintain a clear learning environment for their employees during an instructional session on the web.

Real-world Experiences

Rosenberg (1999) states that a business's achievement is measured by its ability to quickly provide services that are of high quality and are cost-effective. In this age, a company's production goals cannot be achieved if the employees lack or are slow in obtaining instant, updated information that helps them to improve their performance. As a result, technology use should be adapted to deliver the correct information to the correct people at the correct time. Emerging technology is the key factor which enhances knowledge-sharing among employees. Therefore, organizations should have a complete understanding of the technology they use for information and learning.

Establishing intranets in organizations means changing the role for education and training. Training becomes different with the use of an intranet. It allows both learners and instructors to interact at various levels. Training and education shifts from traditional classrooms, conferences, seminars, and workshops to online learning and performance support, as well as knowledge repositories. This strategy of knowledge management and performance improvement enables quick access to enterprise knowledge at lower level of cost (Rosenberg, 1999).

The use of an intranet in organizations changes the level of performance for the employees. They can find the information they need to be successful performers; employees become knowledge and information seekers. Also, self-directed learning becomes one of the preferred methods of learning for each and every employee. Eventually, this use leads to a rapid growth opportunity for the education and training profession. When looking at the number of people using the intranet of the company, it is

evident that the cost is extraordinarily compelling. By using intranet-based learning, employees can learn while they perform their job (Rosenberg, 1999).

Prewitt (1998) argues that computers will never be as effective as humans when it comes to employee training. The role of computers in training is merely providing efficient, timesaving ways for operators to train workers without pushing them too hard. According to Prewitt (1998), most people prefer stand-up training instead of computer-based training (P. 62).

In computer-based training, trainers want to teach skills and skill-buildings habits. Computer-based training (CBT) utilizes limited teaching strategies, such as drill-and-practice strategy. CBT was designed so that learners can go at their own pace. For example, the learners can go back at a convenient time to complete any unfinished tasks. However, one of the main pitfalls for computer-based training is obtaining immediate feedback. Pylant, as cited by Prewitt (1998), states that the problem of CBT is that if learners do not understand immediately what it is going on, it is difficult for them to get back on track. However, in one-on-one training, direct interaction takes place and the process of learning is much easier. Another weakness of CBT is that there is no automatic way to determine what the learner has learned. Lobster, as cited by Prewitt (1998), describes online help as a passive method of CBT. However, Pylant explains that it can be active and have easy instructions to follow. CBT programs that provide “look and feel” media elements can be beneficial (p.62). These programs can be easy to update if system changes occur. However, they still cannot provide feedback. The main advantage

of a tutorial program is that it connects the actual job tasks to what is learned in the application.

Although CD-ROM technology has a few limitations, it has many strengths. Some of the advantages of CD-ROM are: high storage capacity, portability, durability, low cost of replication, inexpensive hardware, availability of title, cross-platform titles, and speed (Barron and Orwig, 1997). The speed factor makes CD-ROM instruction more desirable than web-based instruction, especially if the learning task requires drilling and practicing (Hall, 1997).

Hall (1997) argues that web-based training can be best utilized in the field of training by providing a method of delivering training that is often less expensive and more convenient than traditional methods. Interactivity and the type of multimedia are key issues in deciding the type of training program used. For instance, interactivity makes the difference between a program that simply presents information and one that actually trains the user. Consequently, web-based training is not limited to depositing information into the user's mind; rather, it takes many forms based on the skills and knowledge needed and based on the learning situation. The simplest form of WBT programs is the text-and-graphics stage because it is easy to develop. Another type of web-based training program is an interactive program. In the training cooperation world, there are different attempts to teach knowledge and skills through using web-based training programs. Strategic Solutions Group (2000), a leading company in technology-based training, provides several effective samples of web-based training courses. Figure 3 shows one slide of these sample courses.

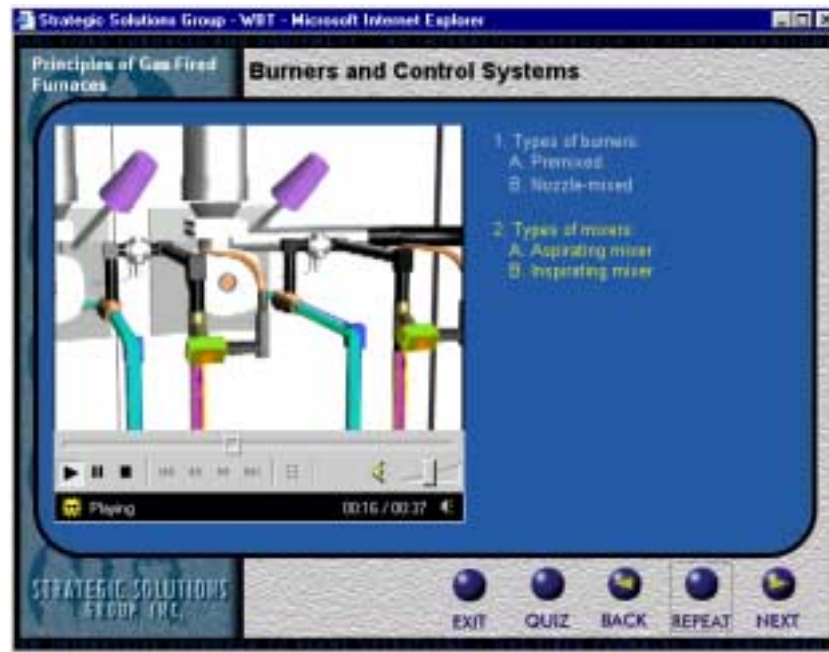


Figure 3. Web-based training sample.

This sample web-based training course aims to teach student to recognize various types of burners and ratio control systems and understand how they work. This high level technical course is designed with the use of streaming video. It further incorporates the video media with other types of media, such as sound and text, to facilitate learning. This type of design attempts to bring the learner into the program to engage with the content and practice certain skills. Examples of this type of web-based training are matching objects on the web, dragging, text entry, programming code entry, etc. Interactive multimedia web-based training programs are known as the holy grail of web-based training. This type of program helps the user to manipulate graphic objects in real time. Java applets or other authoring tools, such as Authorware, play an important role in designing these programs. Interactive multimedia web-based training programs make learning more realistic, effective, and enjoyable. Best of all, it provides the training in a

risk-free environment, as explained by Hall (1997) instead of dangerous, complicated equipment

Some companies now are following a new trend, distance learning and computer-based training in one (Hall, 1997). In this type of training program, the trainer can access and view what is on the user's screen. Two companies have developed training programs that illustrate this new trend. Waters (1999) states that instructors can direct their students to play a CD-ROM during the delivery of the course. Another example of this trend is downloading databases by connecting to libraries home pages. The user needs to first access the library home page, then the user can select a specific database CD-ROM at another remote location.

WBI has a substantial influence on the field of training and development. Through designing WBI programs, the learning process becomes more interesting to the trainees. The learners do not need to attend regular classes; they do not need to feel that they are being burden with information. Indeed, WBI programs motivate the learners to incorporate curiosity, suspense, and surprise. From an educator's point of view, this motivation of learning increases learners' retention of the material. In addition, WBI programs allow the learners to repeat the experience that they went through by returning to the web site as desired.

Design and Development

Web-based training should not be understood as simple work that can be done by a single individual even though it is easy to develop. Indeed, it requires a cross-functional team, which should cooperate to plan, design, develop, implement, and deliver the

program. The team should select a project or a program that will have a significant impact on the training profession; it should be work that makes the learning process dynamic and effective. Most importantly, a web-based training team must understand the principles of instructional design and master the fundamentals of instructional technology and distance education (Driscoll, 1999b).

There are many instructional system design models. For example, the system development life-cycle of Gagne, Briggs, and Wager (1992), Smith and Ragan (1993), Kemp, Morrison and Ross (1994), R2D2 (1995), Reiser and Dick (1996), Dick and Carey (1996), and Seels and Glasgow (1998) consists of different phases that mainly include: analysis, design, development, implementation, and evaluation (Seels & Glasgow, 1998). These phases are called in the training and development field the ADDIE model (Craig, 1996).

Web-based trainers or specialists should understand that web-based training takes several forms, in which different objectives, methods, strategies, and tasks are presented. W/CBT, web/computer-based training, is used in organizations to teach individuals clear instructions (right/wrong). A W/EPSS, a web/electronic performance support system, is used for sharing experiences and practices. W/VAC, web/virtual asynchronous classrooms, allow the students and the instructor to engage in a collaborative work. They rely heavily on programs such as email, online forums, bulletin boards, and listservs. They require more time to allow for participation from all individuals; they also demands good writing skills. Another type of web-based training is W/VSC, web/virtual synchronous classrooms. Internet Relay Chat (IRC), audioconferencing, and

videoconferencing on the web are examples of W/VSC. It allows learners to interact in a real-time environment. This characteristic permits the learners to raise issues and reach consensus in a single session (Driscoll, 1999b).

The choice of any of the above types of web-based delivery will require an appropriate choice of technology. It is a commonly held view that some computer software and hardware are more appropriate than others; the choice should be based on the given situation. However, the level of technology effectiveness in enhancing the instructional and learning processes remains to be seen, especially with distance learning (Recker, 1997).

Many sites are available for WBI designers to assist them in the development of their courses. The American Society for Training and Development (ASTD), located at <http://www.astd.org>, allows for networking, information sharing, and access to pertinent resources (Pamela and William, 1999). Another organization provided by Pamela and William is the Association for Educational Communications and Technology (AECT), located at <http://www.aect.org>. It provides leadership in the field of training and development by linking professionals who have an interest in the use of educational technology and its various applications to the learning process. The Academy of Human Resources Development can be found at <http://www.ahrd.org>. This site is described as a global community of human resource development scholars. ITTA, the Information Technology Training Association, is the trade association for professionals and companies involved in the IT training industry. ITTA's URL is <http://www.itta.org>. For the professionals whose work requires knowledge of instructional technology, they

should access the Society for Applied Learning Technology's (SALT) web site. It is located at <http://www.salt.ogr>.

Pamela and William (1999) also provide valuable web sites for publishers and booksellers. If included in the development of the training course, these web sites can assist learners who visit these sites to buy the books they need. The largest, most popular bookseller on the WWW is Amazon, which is located at <http://www.amazon.com>. Visitors can browse through 28 subject rooms; consumer can search by author, title, keyword, or ISBN number. It allows for providing feedback on any purchased book so that others can view what has been said about a book before they place a purchase order. Trainers, as course designers and instructors, can access a great web site located at http://www.trainingsupersite.com/TSS_Link/lakeset.htm. This site allows visitors to access current articles, request a free magazine or newsletter issue, or search an archive of articles published by Lakewood dating back to 1993.

Pamela and William (1999) present different sites related to the U.S. Government Agencies category. The most important one is the home page of the U.S. Library of Congress, which is located at <http://marvel.loc.gov/>. It has more than 17 millions books, as well as maps, manuscripts, etc. In the category relating to Educational Institutions, Pamela and William (1999) provide a site that helps visitors learn the HTML language. This site is located at <http://www.ncsa.uiuc.edu/General/Internet/WWW/HTMLPrimerAll.html>. AskEric, located at <http://ericir.syr.edu>, is maintained by the Educational Resources Information Center (ERIC). The Theory Into Practice (TIP), located at <http://www.gwu.edu/~tip>, includes a summary of fifty major theories of learning and

instruction. The most interesting site for the training professional is Big Dog's human Resource Development Page, which is located at <http://www.nwlink.com/~donclark/hrd.html>.

The web development process consists of five major steps: analysis, design, production, implementation, and evaluation (Driscoll 1998; Hall, 1997). To start a web development project, a trainer needs to have input in order to develop a vision and decide the methods for delivering instructions. A web-based training team should include a manager, instructional designer, lead programmer, multimedia developer, web master, and client contact (purchaser).

Executives who request training for their companies need to be convinced of the profitability of web-based training. Therefore, a team project should make apparent executives that web-based training has a lower implementation expense than alternative forms of training. Managers' demands need to be considered by the web-based training development team; for example, managers might need privacy to complete the training course without sitting in a classroom with their employees. The major concern for trainers is that a computer will replace their function in the company. Returns on investment studies would prove to the training department that web-based training is the best approach to meet their training needs. To compare the cost of training for web-based training versus alternative means of training, divide the total cost of design, development, duplication, delivery, and support over the life of the course by the total number of students over the life of the course. Many factors determine the price of the courseware of

training. Some of these factors are server hardware (upgrading cost), software, development team (external or internal), and maintenance cost (Hall, 1997).

Planning for web-based training projects must be undertaken in connection with the Department of Information Technology (IT). The Department of IT is familiar with the technology specifications that help in developing successful web-based training course. In the past, converting a training course over the web, one had to consider the audience size and location, cost of the program, nature of the content of the course, and its popularity. Furthermore, there are other considerations regarding the number of learners and the distance of learners from existing training sites. Because of these considerations, trainers can start the web-based training development process and reduce future problems.

Good web design has a clear information structure for the user to follow (Hall, 1997). Creating instructional design, graphics, and simulation are the basic elements for effective web sites. Poor quality of media can be corrected with good instructional design, but the other way around does not work. Graphics must be meaningful and catch the user's eyes. Over use of graphics does not necessarily enhance the design; indeed, it may ruin it. Consistency, use of white space, informative titles, use of colors, and testing of the web page on various browsers ensure a high level of usability (Hix & Hartson, 1993). Authoring systems allow for designing successful web-based training programs. The metaphors for authoring programs are icon-based, card-based, and timeline-based. Authorware is one of the leading tools for creating interactive training programs. These tools walk the designer through the instructional process. The web design process

involves many steps, such as identifying needs and problems, writing instructional goals, using a mission statement to define a project, and understanding the target audience (end user) (Driscoll, 1998).

Hall (1997) identifies three levels of web-based training courses. The first level is a text/graphic course. One type of text/graphic web-based training program is email. Email is simple to use and works at the learner own pace. Another type is a discussion group; it is also known as forums or bulletin boards. The second level of web-based training courses is interactive text and graphics, such as Internet Relay Chat (IRC). The disadvantage that accompanies such course designs is that they are time consuming and the development of such courses is complex. However, they increase the user's motivation to learn. In some situations, interactivity is the only solution for making a training program that is successful and meets the specific needs of the learners. The third level of web-based training courses is interactive multimedia. Shockwave technology assists in the leap from computer-based training to web-based training by allowing trainers to create fully interactive multimedia productions through web browsers. For example, interactive multimedia allows the user to enter a question and will respond if the question was recognized; otherwise, it asks the user to rephrase that question.

Role of the Instructor

The role of the instructors in WBI is different from those of the traditional classroom environment. Clay (1999) declares that teacher roles vary based on the given situation. He concludes that instructors in WBI move more toward facilitation rather than lecturing.

Clay (1999) found that instructors who do well in traditional classroom settings encounter problems in adapting their styles to a distance-learning format. He further explains that such instructors commit some common mistakes. For example, using fancy graphics, audio, or video with a real purpose results in frustration and a lack of education for students. Another common mistake made by online instructors is putting the whole textbook online, which does not only violate copyright issues, but also causes the learners to get overwhelmed with reading from a computer screen (Clay, 1999).

Hix and Hartson (1993) and Waters (1999) recommend following human-computer interaction guidelines when designing computer internet-based courses. Instructors should create a clear structure that allows for inevitable changes. Maintaining a clear focus can be achieved by avoiding unnecessary links that might mislead the learners (Waters, 1999). Also, good web based interface design increases usability (Hix & Hartson, 1993) and therefore enhances learning.

Ashe and Buell (1998) describe the role of the instructors in distance learning as people who encourage the learners to be more involved, offer individual feedback, and promote interpersonal relationships with them. The role of the instructor using WBI method is a major issue in the instructional design process. Fister (1998) presents different sites, where web-based training designers can browse to get more knowledge and even skills to help them provide efficient and effective web courses. DELPHI FORUMS, www.delphi.com, and TUCOWS, www.tucows.com, provide chat tools, HTML editors, animation, and image editors, and Internet and browses accessories for the users. CGI RESOURCE INDEX, www.cgi-resource.com/Programs_and_Scripts/, is

the best site for web-based training designers to visit when they have no programming skills and want to add forms, tests, or surveys into their web sites. Common Gateway Interface (CGI) can help you create tables, monitor the number of users to visit the site, and create surveys. Another web site that the author advocates for the instructional designers of web-based training is located at <http://homebrew.cs.ubc.ca/webct/webct.html>. These sites help teachers and trainers design their courses and manage them on the Internet (Fister, 1998).

Role of the Learner

Sensible web-based instruction programs start analyzing and assessing learners' needs as in the traditional methods of instruction. The only difference between the two methods of instruction is that web-based instruction emphasizes the role of the learner in making the learning process more effective. The constructive theory plays a important role in understanding the significance of the learners in web-based courses. McGee (1998) describes web-based training and computer-based training students as receptive and enthusiastic, especially when it comes to acquiring new technology skills. Slusky, Yampolsky, Partow, and Dubina, as cited by Partow-Navid (1999), conclude that the unwavering efforts of students, faculty, facilitators, support staff, and administrators makes distance-learning programs successful.

Web-based instruction learners have a more significant role than their roles in the traditional classroom. They have a greater responsibility in manipulating and directing the content of the subject. From the instructor's viewpoint, WBI students are the center of the learning process; they can be described as active and critical thinkers. Within the

framework of learner-centric theories, instructors' roles also must change to be a catalyst, coach, and a program manager (Leonard, 1999).

Learning Domains

Instructional Objectives and Domains

Instructional objectives have been classified according to three domains of learning. Objectives that involve knowledge are classified in the cognitive domain. Objectives that involve skills (e.g. physical skills) are classified in the psychomotor domain. Objectives that involve attitude are classified in the affective domain (Sullivan, Wircenski, Arnold, & Sarkees, 1990).

The instructional objectives should correspond to one or more learning domains. Taxonomies have been widely used to define learning within each of these domains. The most popular examples are by Bloom et al. (1956) for the cognitive domain, Bloom et al. (1964) for the affective domain, and Harrow (1972) for the psychomotor domain. In reality, it is difficult to separate these, although it is possible to clearly emphasize one over the others.

The instructional objectives should be appropriate for the learner's level of ability. Many learners may need prerequisite skills and knowledge to succeed with any delivery system (Seels & Glasgow, 1998).

The instructional objectives should be appropriate for the tasks associated with the subject matter. A clear description of the topic and the steps necessary to achieve these goals leads to clear instructional objectives. Task analysis is frequently employed

order to define the operational components of a skill or subject matter (Jonassen & Hannum, 1995).

The instructional objectives should be appropriate for the learning situation. This can be simply determined by adjusting to the class size (Sullivan et al., 1990).

Furthermore, it is necessary to identify whether the instructional objectives require independent or group study and to identify the appropriate physical locations for the students to perform the task.

The cognitive domain emphasizes memory and problem solving after receiving instruction. “Cognitive objectives vary from simple recall of material learned to highly original and creative ways of combining and synthesizing new ideas and materials” (Bloom et al., 1954, p. 6). Many educators agree that the cognitive domain is the most important domain of learning because it accompanies most learning situations. Unlike the cognitive domain, the psychomotor and affective domains fit only some learning situations (Bloom et al., 1954, p. 6). For example, psychomotor objectives involve manipulation of materials or objects. Bloom et al. (1954) state that the objectives in the psychomotor domain “emphasize some muscular or motor skill, some manipulation of material and objects, or some act which requires a neuromuscular co-ordination” (p. 7). Objectives in the affective domain require more time to accomplish than those of the other two domains of learning.

Cognitive Domain

Bloom et al. (1954) classify the cognitive objectives into six levels or categories starting from the easiest, level one, to the most difficult, level six. Figure 4 shows these levels.

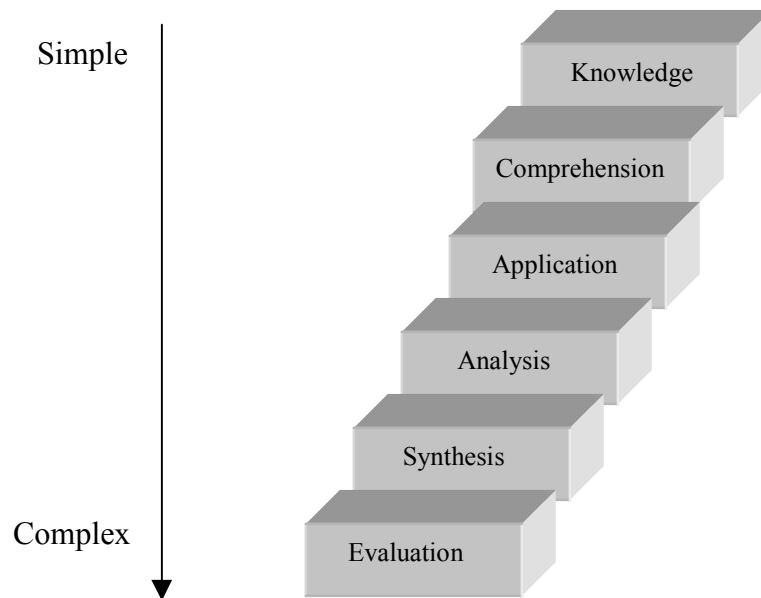


Figure 4. Levels of cognitive domain.

In the knowledge level, the curriculum designer can define the lowest level of learning outcomes. This level centers on remembering information and facts that are essential to the given subject matter. The second category in Bloom's development of curriculum is comprehending the meaning of the given material. This level represents the lowest level of understanding. The third category is the application of what was learned. Here the level of understanding is higher because it requires the learners to apply the acquired knowledge to unanticipated situations. In the analysis category, the curriculum designers

must provide the learners with activities that enable them to break down the material to parts, relate them to each other, and recognize the organizational principles involved. In the synthesis category, learners must be provided with activities that help them measure their abilities to put parts together. For example, the curriculum designer might ask the learners to come up with new conclusions related to a task in their job. Such activities give students the skills necessary to apply to real world situations. The last category of Bloom's conception of curriculum design is evaluation. The learners should be able to judge the value of material for a given purpose. Thus, they can decide, debate, discuss, and choose the most suitable materials for their job.

Driscoll (1999) concludes that web-based training is shrouded in myths about the use of web-based training in the training world. She discusses three popular myths: web-based training can be used to deliver all types of training; web-based training refers to a single independent delivery method; and an individual can implement web-based training. She reveals valuable facts about the use of web-based training to achieve various training purposes.

The cognitive domain is best suited for web-based training (Driscoll, 1999b). For example, teaching someone to plan for a vacation works well on the web. In support of Driscoll's theory about the suitability of the cognitive domain to the web, Hazari and Schnorr (1999) argue that WBI can not only provide for cognitive learning, but also evaluate student learning in this domain. They believe that assessing student learning by designing feedback forms enhances the quality of WBI. This type of web-based

assessment provides opportunity for students to demonstrate what they are learning and analyze the course content in a direct and focussed manner (Hazari & Schnorr, 1999).

In addition, Colbrunn and Tiem (2000) advocate some courses that are ideal for web-based delivery. Courses that focus on content and information are good candidates for web-based learning. However, they doubt the appropriateness of all levels of the cognitive domains to the web medium. Colbrunn and Tiem (2000) indicate that the first three levels of the cognitive domain (knowledge, comprehension, and application) are appropriate for the web, but the last three (analysis, syntheses, and evaluation) require careful considerations during the instructional development process of the course.

However, Driscoll (1998) ensures that all levels of the cognitive domain can be delivered via the web, and its ability to deliver high level intellectual cognitive skills depends on the quality of the instructional design. Table 3 distinguishes among the four types of web systems and relates them to the six levels in the cognitive domain (Driscoll, 1998).

Table 3

The Ability of Four Types of WBI to Deliver Cognitive Skills

Cognitive Level	WBT type			
	Individual Delivery		Group Delivery	
	Web/CBT	Web/EPS	Web/VAC	Web/VSC
	Systems			
Knowledge	✓			
Comprehension	✓			
Application	✓	✓		
Analysis		✓	✓	✓
Synthesis		✓	✓	✓
Evaluation		✓	✓	✓

Table 3 presents four types of WBI. Web/CBT is web/computer-based training program. Web/CBT delivers instruction for individuals, not groups. This type of WBI has the ability to deliver lower-level cognitive skills. Web/EPS Systems stands for web/electronic performance systems. It has the ability to deliver a higher level of cognitive skills. Web/VAC stands for web/virtual asynchronous classroom. Web/VSC stands for web/virtual synchronous classroom. Both Web/VAC and Web/VSC deliver instruction to groups of individuals and are able to deliver high-level intellectual skills (Driscoll, 1998).

Web-based training programs can be utilized to test an employee's knowledge of a given subject. This type of testing on the web is easy, private, convenient, and efficient (McMasteres, 1999). For example, the learner, at any time, can access a training session and interact with the system to test his/her knowledge of certain skills. Furthermore, the learner can receive immediate feedback.

Psychomotor Domain

Simpson, as cited by Gronlund and Linn (1990), defines seven major categories in the psychomotor domain: perception, set, guided response, mechanism, complex overt response, adaptation, and organization (see Figure 5).

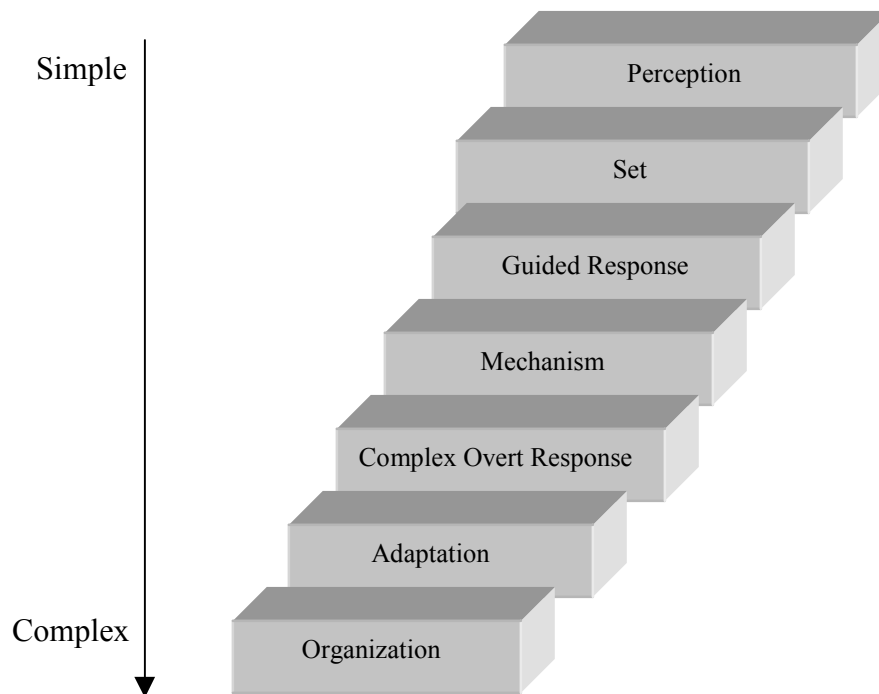


Figure 5. Levels of Psychomotor Domain.

Perception is the first level of the psychomotor domain. Gronlund and Linn (1990) state: “This category ranges from sensory stimulation (awareness of a stimulus), through cue selection (selecting task-relevant cues), to translation (relating cue perception to action in a performance)” (p.510). Set is the readiness level to act physically, emotionally, and mentally. Perception serves as an important prerequisite for this level. Guided response is the act of repeating the skill that has been demonstrated by the instructor. Mechanism is the level in which a learner has a habit of the skill that was gained during the course of study; the movements are slower at this level. Complex, overt responses involve the motor acts of performing a skill confidently and proficiently. Adaptation is the modification of a movement to meet the special needs of a given situation. Organization is the creation of new movement patterns to meet the needs of a specific situation (Gronlund & Linn, 1990). In addition to communicating a body of knowledge, the Internet can be effective in transferring specific skills (Derringer, 1999).

Driscoll (2000) argues that web-based instruction cannot effectively deliver psychomotor objectives. The psychomotor domain is difficult to influence through web-based training (p.38). Skills in the psychomotor domain are not well suited for web-based delivery because they require coaching and detailed feedback. This involvement requires two kinds of ongoing reinforcement, which are difficult to demonstrate on the web. Consequently, Driscoll (2000) contends that depending entirely on the web to deliver psychomotor objectives or affective objectives will not be as effective as delivering cognitive objectives.

“As a stand alone medium, WBT is not well suited to teach psychomotor skills such as how to give an injection, hit a tennis ball, or style hair. These are skills that require fluidity of performance and coaching to master the skill.

Teaching things such as how to change the toner cartridge in a printer would work well on the Web, this task does not require a fluid performance and the learner can stop and start as often as her or she needs

...Content in the psychomotor and attitudinal domain is often found on the web and the programs can improve learner performance, but as training professionals, we should be advising our clients to optimize the environment for learning. This may mean recommending hybrid programs that use both the web and live instruction. Make learning as effective and efficient as possible put cognitive skills on the Web and use other methods to deliver psychomotor and attitudinal skills and knowledge” (Driscoll, 1999b, p. 1-2).

Furthermore, Hoekman (1999) reports that coaches do not believe that teaching via the web is effective for real psychomotor skills; however, it can help people improve soft skills areas, such as sale techniques or computer application software. In addition, Colbrunn and Tiem (2000) support this theory by stating that “the web is not the right delivery mode for technical situations where body movement practice is needed relative to assembly operations or where patient medical conditions need to be assessed and inferred through sight, sound, and touch” (p. 37). Therefore, delivery of psychomotor skills on the web should be incorporated with other traditional methods of instruction.

Knowledge acquisition can greatly affect motor-learning (Akhtar, 1976; Kerr, 1982). A review of the literature supports that the acquisition of psychomotor skills is influenced by the amount and type of knowledge received. Henke (1997) provides an example of the association between the psychomotor domain and the cognitive domain: “The use of screen printing to produce a design on a shirt is accomplished pulling a squeegee across a screen and is considered a psychomotor task; however, to perform the task skillfully, one must first understand why pressure from the squeegee affects ink density and make an attempt at producing consistent quality results.”

In addition, delivering psychomotor objectives with the use of technology “saves time, money [sic], and reduces safety concerns while enhancing total domain learning” (Henke, 1997, p. 41). For example, using the web to repeatedly demonstrate a learning task that requires expensive use of materials saves more time and money than showing the same task repeatedly in a traditional classroom setting.

Principles of Adult Learning

Adult Learning Theories

WBI is conducive to adult learning situations. Adults can learn at their own pace, removing conflicts with job and family obligations. Research studies have shown that adult learners tend to be self-directed. Malcolm Knowles, as cited by Craig (1996), defines the term pedagogy, as the art and science of teaching children. Unfortunately, educators and trainers have known the model of pedagogy as the only method of teaching, applying this method to adult situations as well. In 1926, Eduard Lindeman wrote a book, “The Meaning of Adult Education,” that changed this old notion (p. 254).

He proposed that adults are not merely grown children, they learn best by engaging in the process of learning. Until the 1950s, research showed that adults are highly self-directed learners. Psychologists and sociologists advocate the idea of viewing teaching adults as promoting behavior change. In the 1960s, European adult educators rediscovered the term “andragogy” that had been coined by a German adult educator. Knowles et al. (1998) explain the idea of “andragogy” as a “set of core adult learning principles that apply to all adult learning situations” (p. 254). The andragogical model is based on six assumptions. The first assumption is that “adults have a need to know why they should learn something” (p. 255). The second one is that “adults have a deep need to be self-directing” (p. 255). The third assumption is that “adults have a greater volume and different quality of experience than youth” (p. 256). The fourth one is that “adults become ready to learn when they experience in their life situation a need to know or be able to do in order to perform more effectively and satisfyingly” (p. 256). The fifth assumption of andragogical model is that “adults enter into a learning experience with a task-centered (or problem-centered, or life-centered) orientation to learning” (p. 257). The sixth assumption is that “adults are motivated to learn by both extrinsic and intrinsic motivators” (p. 257).

Using the pedagogical model leads the educators to think in term of drafting a content plan. The educator needs to answer few questions to come up with a plan. For example, he/she might ask questions, such as what content needs to be covered? How this content is divided into units? How can these units are transmitted in a logical order? What are the best methods of delivery (Lectures, reading assignment, etc)? The

andragogical model, on the other hand, leads educators or trainers to think in term of a process design. The implementation of this process requires six elements of andragogical process design. The elements are climate setting, creating a mechanism for mutual planning, diagnosing the participant's learning needs, translating learning needs into objectives, designing and managing a pattern of learning experiences, and evaluating the extent to which the objectives have been achieved.

Andragogy should not be viewed as the opposite of pedagogy. Many educational institutions have found that andragogy is very practical with children in some situations when they are involved in sharing responsibility. An effective trainer can use both the pedagogical and the andragogical approaches interchangeably based on the type of task and the given situations (Craig, 1996).

Self-directness means that the ability of individuals to learn continuously by developing good reading skills, listening skills, and observational abilities, and possess the skills of reflection. This characteristic can be increased or decreased based on the work environment. A team that depends on self-directed manner requires members that must be strongly self-directed (Craig, 1996; Piskurich, 1993). Self-directness is essential for individuals who support learning organization. Research supports the idea that we are not all self-directed (Craig, 1996). The lack of self-directness is not normally due to any genetic or psychological limitations. It seems to be acquired response to a society in which learners are “spoon-fed” and “hand-held” during the formative years of their learning. Now, how can training program enhance self-directedness? Research indicates that it is not only possible but also quite achievable. Zemke (1998) states that today's

organizations must encourage their employees to become self-directed learners (SDL). Indeed, SDL has proven a practicable means for learning supervisory skills, accounting and finance, computer programming, electrical schematic, etc.

Companies, when applying web-based instruction, should make self-directed learning an initiative that the company supports. French et al (1999) state “for students to use Internet-based materials effectively and move away from regarding the teacher as ‘sage on the stage’, they must learn to become self-directed and to not remain passive receptors of knowledge. The ultimate goal is to increase access to knowledge and facilitate learners becoming life-long learners” (p. 10). The companies should convert from a corporate-controlled system approach to an employee-driven system approach. This shift will help the company to have standby staffs, who are able to meet all the challenges that their company faces. In this working environment, the employees are willing to take on all sorts of learning challenges and capable of mastering the skills and absorbing the information that their employers would like them to learn. In addition, self-directed learning facilitates acquiring specific individual’s needs that otherwise cannot be achieved. When managers sit down with their employees to review the employee’s competencies and discuss the employee’s job needs, the managers are actually (a) developing individual plans for the employees; and (b) making a needs assessment for them.

Adults prefer self-directed learning to any other learning style (Zemke, 1998). Why? They tend to seek out knowledge and acquire skills on their own; they just need to be informed of the needs of the organization. The web can be a powerful tool that

supports adult learning. It provides the opportunity for self-directed learner to manipulate the learning environment based in his/her learning needs. McIntyre (2000) ensures that web-based learning contribute to adult learning and boost their self-efficacy. The web makes a huge difference in adult learning since there are no boundaries as in traditional education. WBI meets the requirements of adult learning theories. For example, it allows for practicing new learning immediately, providing regular feedback, adjusting the levels of difficulty, adjusting the learning pace, controlling over the sequence of the information, reviewing, correcting, or repeating the information, entering, exiting, and re-entering the program without repetition, and saving responses for future use. Therefore, WBI allows for feedback, interactivity, and repetition. Consequently, the web gives enormous power to adult learning (McIntyre, 2000).

A role of a manager becomes increasingly important when implementing web-based learning in his/her organization. He/she needs to remind the individuals that they already know a lot about managing their own learning (Zemke, 1998). McIntyre (2000) outlines two problems with using the web: 1) it requires a certain level of computer skills, so adult learners who do have these skills may perceive this method of instruction as not user-unfriendly; 2) the web can have technical problems that can be extremely frustrating and can interfere with the learning process. Therefore, Educators also must hardly try to get the learners interested and ready to improve their skills with web-based instruction. Lyman (French et al, 1999) conclude that

“adults learner’s goals and the goals of employers and higher education institutions, as well as the goals of trainers and educators for adult learners,

represent overlapping and extensive arrays of knowledge and skills. The lifelong learning required to develop the skills within a model of continuous human potential development begs for a medium such as the Internet. The Internet as a medium is striking in its ability to promote learning through sites the archive information in databases, support the exchanges of learning communities...” (p.115-116).

Adult learners should be trained on the basic skills and knowledge to help them direct their own learning on the web. This is called “learning to learn in web-based environments” (French et al, 1999, p. 29). Because web-based learning is new method of learning and training, managers and educators should prepare adult learners to face the new challenges. For examples, they should learn how to articulate and reflect when facing new terminology that are related to WWW. Meeting these challenges make the learning on the web user-friendly. McIntyre (2000) provides six benefits resulted from learning on the web, they are: (a) The learner can take active part in the learning process, either synchronously or asynchronously; (b) The learner, or the employee, can save time and expenses by accessing the instructional course from home or work; (c) Work assignments can be done at the most convenient time and place for the learner; (d) The learner has control over the learning pace; (e) The opportunity of selecting of courses would be greater with web-based instruction; and (f) The opportunity to communicate with subject matter experts would also be greater on the web.

Adult Learning Experiences with WBI

Technology and the Internet have made shift in educational focus. According to French et al, (1999), “industry is leading higher education in the move away from traditional teaching and training roles to encourage learners to take charge of their learning” (p. 13). Web-based training programs can be easily delivered to the learners in an individualized manner. Based on his/her preferred learning style, a smart web-based training system can look into the user’s eyes and determine the best way for presenting the information, which the user is ready for. Web-based training programs reduce the instructional time to teach competencies that the learners have already demonstrated. Furthermore, as some studies show, the time for mastering an objective is reduced by using multimedia and interactive computer programs. For example, it may roughly take a learner 50% of his/her time to acquire a certain skill by using multimedia programs than traditional media. In terms of testing and evaluation, web-based training programs test the users’ abilities of accomplishing particular tasks. Well-designed web-based training programs can test the level of understanding and even provide dialectical dialogue to examine whether or not the user has comprehend the foundational instructional objectives.

Furthermore, Ashe and Buell (1998) present findings in other studies that show no difference in the level of achievement between distance-education learners and traditional learners. In addition, the authors describe the characteristics of distance-education learners as job seekers, adults, and professionals. These learners tend to gain knowledge that can be applied in their daily lives or in their jobs. Also, they have a desire for

learning by doing and obtaining instructor comments. In contrast with traditional classroom instruction, in which adult learning programs miss the mark by taking a pedagogical approach, WBI has shown to be motivated instead of discouraged by creating an atmosphere of encouragement and coaching (McIntyre, 2000).

Not all individuals are prepared to use the information delivered via the Internet. Other individuals do not feel the responsibility of their learning; therefore, different considerations should take place based on the learning situation. Furthermore, organizations should be more aware of the importance of the web-based training in enhancing the performance of the employees (Driscoll, 1999). Adult learners want to control their learning environment. This includes controlling the pace, content, appearance, presentation and modalities of the course whenever possible. WBI addresses these concerns by providing the learners with the maximum amount of control possible over their learning environment.

Gender Issues with Online Learning

During the last few years, studies have shown that women have negative predilections about computers, whereas men seem to feel powerful in relation to the computer (Proost, Elen, & Lowyck, 1997). There are some factors that contribute to this positive male attitude. One of these factors is that males traditionally receive more encouragement from parents to pursue computing activities and careers than females. Another factor is that males are found to be much more likely to have access to computers. Telematic Learning Environment (TLE) provides direct communication between the teacher and the students and among the students themselves. Therefore, this

study investigates the interrelationship between gender, preference for and perception of the various technology used in TLEs, prior experience with technology, and preference for social contact.

A questionnaire consisting of two parts was used to measure students' attitudes toward TLEs and to assess demographic information. Answers were charted on a Likert-type scale ranging from 1, totally disagree, to 5, totally agree. Proost, Elen, and Lowyck (1997) admit that the sample used in their study is not fully representative because students were selected based on availability and willingness for participation. Moreover, further research needs to be carried out to clearly identify which variable determines students' perceptions and preferences in using computers as learning environments (p. 41).

The results indicate that women have a significant negative perception about computer-based technology and stronger preferences for traditional methods than men. However, gender could be irrelevant to these results; rather, the experiences of those women may have changed their perceptions of learning. Furthermore, numerous research studies have found that both men and women have had successful experiences with computer use and felt confident in working with technology (Proost, Elen, & Lowyck, 1997). Nevertheless, female participation in information technology courses is low (Moffatt, 1997).

The National Assessment of Educational Progress (NAEP) claims that there are differences in the performance of male and female students in the fields of mathematics, computer science, and information technology (Aldhafeeri, 2000). At the college level,

women on the average still achieve less than men in these fields. In his four-years of study at the University of British Columbia, Professor Douglas Willms, as cited by Aldhafeeri (2000), finds that women tend not to excel in problem solving and mathematical concepts. This educational variances creates the perception that women are weak in math, which may influence their career choice.

Aldhafeeri (2000) relates the differences in male and female learning to social experience, not gender type. She contends that society's perspective of women affects their performance and career choices. Henke (1997) agrees with Aldhafeeri (2000) that instructional development, which is based on the understanding of gender differences, can complement both gender preferences. Furthermore, Aldhafeeri (2000) provides some guidelines and recommendations that should be considered during instructional design to reduce gender difference: (a) provide equal time for males and females to ask and answer questions; (b) discuss subject content anxiety with females who are having problems and try to help them overcome these problems; (c) call on males and females equally; (d) use questions and comments to encourage females thinking skills; by talking with them about ideas and theories; (e) put females in touch with female theorists and leaders; (f) design activities that are fun, relaxed, and collaborative and include hands-on work and problem solving; and (g) use their voice, gestures, attitudes, and body language in a way that does not convey about gender.

Summary

Not enough research has been conducted to measure and analyze the effects of WBI on either cognitive or psychomotor learning. Few studies have shown that WBI is

effective on the cognitive domain only; it also has the ability to influence learning in the psychomotor domain. The psychomotor domain requires more preparations and high-tech instructional design to be delivered via the web. Several researchers suggest incorporating traditional methods of instruction with the online delivery of psychomotor learning. Many other related research studies show that the web, as a form of distance learning, is as effective as traditional classroom instruction. However, most of these studies do not examine the effects of this new method of delivery on actual students' learning; rather, they focus on students' perceptions toward distance learning in general and the web specifically. Many authors in the fields of training and education agree on the appropriateness of the web to accommodate adult learning situations. In addition, the literature revealed that WBI is a method that can be described as cost-effective, simple to design, and efficient. In terms of gender, theorists ensure that learning differences in gender are due to social experiences and not to the medium used. In general, the review of the literature in this chapter provides differing points of view about the effectiveness of the web, as an instructional method of delivery, on the cognitive and psychomotor domains for adult learners.

CHAPTER 3

METHODS AND PROCEDURES

Web-based instruction (WBI) has become a prominent trend, so that many organizations and educational institutions must be aware of its importance in boosting the learning process. Adult learners who prefer to be self-directed learners can learn best through WBI (French et al., 1999). Both the cognitive domain and the psychomotor domain need to be examined to see if they can be effectively learned through the web.

This section describes the methods and procedures used in the present study. It starts with the identification of the subjects who participated in the study. This is followed by description of the research design, which establishes the independent variables and dependent variables. Next, instruments used in the study are described. Then the procedures to collect data, statistical analysis, and the hypotheses to be tested are explained.

Population

The target population of the study was graduate and undergraduate students who were enrolled in summer courses offered by the Applied Technology, Training and Development program (ATTD) in the department of the Technology and Cognition at the University of North Texas, Denton. Eight courses were offered for the summer 2000 semester. Four of them were for the undergraduate level. The other four courses were

offered for the graduate level. The total number of graduate and undergraduate students who were enrolled in summer courses offered by the ATTD program was 50.

Sample

Subjects were selected from the defined population by using a cluster sampling method. It was more feasible and convenient to select groups of individuals than to select individuals from a defined population (Borg, Gall, & Gall, 1996). Classrooms were selected based on the instructor's cooperation. Subjects were graduate and undergraduate students who were enrolled in summer courses offered by the program of Applied Technology, Training and Development in the College of Education at the University of North Texas.

Appendix A provides a table of the required sample size (Krejcie & Morgan, 1970) for a defined population. Approximately 50 students were enrolled in summer courses offered by the ATTD program, and these students constituted the population of the study. Thus, the appropriate sample size for this study was 44 graduate and undergraduate students.

Ethical Standard

Participation in the study was voluntary and there was no extra credit granted for participation. The subjects in this study were not exposed to any unreasonable discomforts, risks, or violations of their human rights. However, an approval to conduct this study was requested from the Institutional Review Board for the protection of Human Subjects in Research at the University of North Texas (see Appendix B). By the requirement of this review board, all participants signed an Informed Consent Form (see

Appendix C). Before they signed the Informed Consent Form, a brief introduction about the experiment and safety tips were provided for all subjects. Furthermore, participants were asked to wear the provided safety glasses before working with soldering a circuit board.

Research Design

The study utilized a true experimental design known as the posttest only control group design. According to Borg et al. (1996), this design controls for history, maturation, testing, instrumentation, statistical regression, differential selection, experimental mortality, and interaction of selection and maturation as sources for internal validity. In addition, the design controls for interaction of testing and X (experimental treatment) as a source of external validity. Figure 6 shows the type of experimental design used in this study.



Figure 6. Posttest only control group design.

It involves comparisons between an experimental group and a control group. The experimental group in this study participated in a web-based instructional session, and the control group participated in a traditional classroom instructional session. Both groups were given a posttest to measure achievement and performance of knowledge and skills, respectively. Knowledge was the cognitive domain of learning. Skill, motor skill, was

the psychomotor domain of learning (Sullivan et al., 1990). The experimental group received instruction delivered via the web. The control group received traditional classroom instruction.

Random selection and random assignment were both considered in this study to ensure that the design met its requirement. Random selection was a use of cluster sampling procedure to ensure that each class in the defined population had an equal chance of being selected to take part in the study (Borg et al., 1996). However, this assumption was violated because some instructors could not volunteer their class time for this study. Random assignment was also used in this study. This procedure was accomplished by putting the name and number of all courses in a hat. Then, these courses were selected and assigned randomly to one of the groups, either the control group or the experimental group.

A factorial design with two independent variables was used for the analysis. The two independent variables were methods of instruction and gender. The study utilized a fixed-effects model because the researcher selected specific levels of interest for both variables (factors) (Hinkle, Wiersma, & Jurs, 1998). Two levels of instruction (traditional classroom instruction and web-based instruction) were crossed with the levels of gender (males and females). With these two factors, two dependent variables were measured-- achievement and performance on cognitive and psychomotor skills gained from the provided instruction.

Based upon the previous research in this area, this study assumed that a standardized effect size (d) is 0.85, a level of significance is 0.05, and power is 0.80.

Table C.12 of Hinkle et al. (1998), in Appendix D, was used to determine the appropriate sample size. For the first independent variable, methods of instruction, the sample size required for each level would be 22, with two levels. The second variable, gender, with two levels, required a sample size of 22 for each level. For two factors design, it is necessary to satisfy the sample size requirement for both of the independent variables, method of instruction and gender. Such a strategy leads to slightly larger sample sizes for the levels of both variables and to more powerful statistical tests. In order to meet the requirements for this 2 x 2 design, with $2 \times 2 = 4$ cells, the sample size for each cell would be 11, as shown in Table 4.

Table 4

Sample Size Requirements

Traditional-classroom instruction		WBI	Total
Male	11	11	22
Female	11	11	22
Total	22	22	44

Instructional Material

The content subject that was delivered in this study was “Learn How to Solder.” It was selected as the content subject because it was considered to be relatively new and of interest to students. Subjects were not familiar with the content subject (nor knowledge or skills). Indeed, none of the subjects in this study showed to have a recent experience with

soldering a circuit board. A few of them indicated that they had had experience with soldering a circuit board more than 5 years ago. Wu (1998) presented recommendations for future research studies regarding delivering instruction via the web. One of his recommendations was to use a small segment of a course to be able to assess students' learning through a WBI course. This recommendation affected the design and the selection of the curriculum of the content subject used in this experiment.

Another important reason for choosing "Learn How to Solder" to be the content subject of this study was that it involves both cognitive and psychomotor objectives, which this study attempted to measure. The researcher purchased the curriculum of the instructional course from Chaney Electronics, a leading company in selling and producing educational electronic materials. After examining their 1999-2000 catalogs of educational electronic products, the researcher decided to buy a soldering course, titled "Learn How to Solder." As a result, the researcher contacted Electronic Goldmine, a retailer for Chaney Electronics, which sold the script, three transparencies, and two multiple-choice tests for \$34.95.

The "Learn How to Solder" course included full-color, high-quality transparencies, teaching scripts, and two multiple-choice tests and their answer keys. The teaching scripts show when to show transparencies, when to introduce the next subject, and how to suggest discussion topics. A final review activity reinforces what was discussed and taught. All instructions were presented at an introductory level. The instructional unit is included in Appendix E (Traditional Classroom Instruction) and Appendix F (Web-Based Instruction).

Instructional Treatments

The instructional treatments that this study utilized consisted of two methods: traditional classroom instruction and web-based instruction. The subject content of the instruction was a short course entitled “Learn How to Solder.” The two methods of instruction were created according to the principles of instructional design that suits the nature of each of the instructional methods used. Appendix E contains the instructional course for traditional classroom instruction. Appendix F contains the instructional course for web-based instruction. Both methods utilized the systematic approach of instructional design and development process. Moreover, a subject matter expert (SME), Brian Urban, delivered the instructional sessions for both of the instructional methods. Urban is a lab manager who has experience in teaching electronics, including the foundational principles of soldering circuit boards. Currently, he is a lab manager in the Department of Engineering Technology at the University of North Texas. Appendix G contains his resume. The researcher chose not to teach this course; however, the researcher and other assistants were available merely to monitor the process of learning and ensure that the learners, either traditional or web learners, had the necessary equipment and tests. More importantly, the researcher wanted to make sure that the participants put on the safety glasses during their interaction with the soldering process.

Choosing not to teach the groups minimized the threats to the external validity of the experiment in this study (Borg et al., 1996). In addition, the researcher provided the instructor with guidelines and cautions to avoid threats to the validity of the study. For example, the researcher asked the instructor whether there was any preference for any of

the instructional methods compared in this study. The instructor ensured that he would teach the two groups equally and enthusiastically. The instructor agreed to sign a consent form stating these conditions (see Appendix H).

Some special equipment was used for each of the instructional methods. An overhead projector was required for the traditional classroom method. For the web-based instruction, a computer, with the necessary software (MS PowerPoint, MS Explorer or Netscape Navigator, MS Word), a monitor, a mouse, keyboard, Internet connectivity, micro, and speakers. Also, a circuit board kit was available for each of the students in both groups. The kit included safety glasses, wire cutters, solder, soldering iron, a damp sponge, resistors, and a practice circuit board. Figure 7 shows the items included in the circuit board kit.

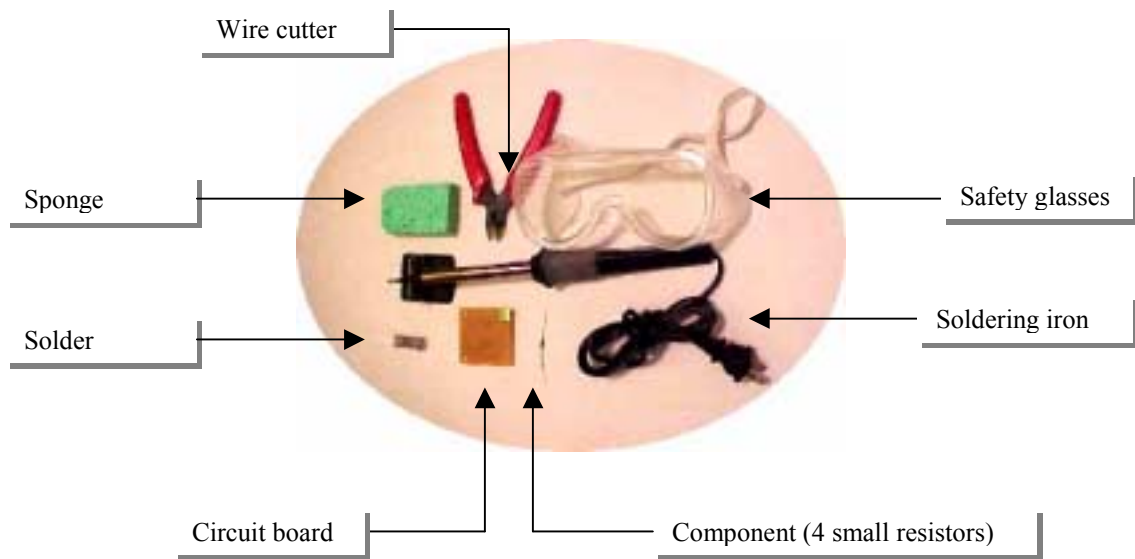


Figure 7. Circuit board kit.

These items were needed for the learners to perform the soldering task during the given course of instruction.

Traditional classroom instruction

The curriculum of delivering a traditional classroom instruction was purchased from a leading company in producing electronic educational materials. This curriculum included instructor notes for teaching the content of the course, as well as transparencies as supporting media to aid the instructional process. The script in this curriculum provided the instructor with techniques to demonstrate effective introduction and summarization. For example, the script asks the instructor to start the lesson with a question that helps the learner conclude the importance of soldering in electrical field. Appendix E has a copy of the traditional classroom instructional material.

This method of instruction took place in a traditional classroom environment. The classroom was ready for instructional delivery using a lecture with black on clear transparencies and overhead projector. The instructor used different teaching/training methods such as questioning, lecturing, demonstration, and group discussion. The learners were encouraged to ask questions and to take an active role during the instruction. For example, the participants performed soldering as a major activity in this method of instruction. Illustration was also used during this instructional method. Illustration and demonstrations were two important training methods that were used in this method of instruction so that the learners could understand the steps involved in soldering a circuit board. The length of this instructional session was 30 minutes.

Web-based instruction

Students in the web-based instruction received instruction via the web. The students accessed the instructional session by typing in the URL, <http://webct.courses.unt.edu/trnc.html>, the address that was given at the beginning of the instructional session. The time of instruction allocated for this method lasted also for 30 minutes of training/teaching. During this instructional session, the students communicated with the instructor over the web and at distance. The instructor delivered the course from a different room, and students were in another room (a computer lab in Matthews Hall, College of Education). There was a lab monitor and assistants with the students whose jobs were not to teach, but rather to ensure that there was no defect in the computers or shortage of equipment, which might have distracted the learners if they were not available. The lab monitor and his assistants had the responsibility to take

appropriate action if there was any distraction that might have affected the validity of the study. For example, the lab monitor replaced two circuit board kits for two of the participants simply because the kits were missing some parts.

The instructional materials were placed on WebCT and organized by topics. Syllabus, course content, and class communication were the major topic links placed in the system. The syllabus topic included information about the course, its objectives, and step-by-step objectives, as well as pertinent information about the instructor and his email address. Appendix F contains a copy of the WBI method that has the syllabus embedded in it.

WebCT is a web-based course delivery system for the University of North Texas. This system requires the computers to be the following: (a) IBM/Intel machines: Pentium-90 with at least 32 Megabytes of memory, a minimum 2 Gigabyte hard-drive, monitor, a sound card and speakers; or (b) Apple Macintosh: Power-PC based machine with at least 32 Megabytes of memory and a minimum 2 Gigabyte hard-drive.

In terms of operating system, it requires (a) IBM/Intel machines: Windows 95, Windows 98 or Windows NT 4.0 ; and (b) Apple Macintosh: System 7.5 or better. The process for applying for a WebCT course was simple. The researcher requested a WebCT course by accessing this URL address: http://courses.unt.edu/webct/request_a_webct_course.htm and filling out the WebCT Request Course Form. Three days later, an email was received confirming that the WebCT course, Soldering Techniques, had been created in the Under Construction subcategory of the Training and Non-Credit Courses category at <http://webct.courses.unt.edu/>. Participants in this study were asked to access this course

by typing the URL address: <http://webct.courses.unt.edu/trnc.html>. Then they had to enter a login name and a password to access the course. The login names and passwords were created by the researcher and provided at the beginning of each instructional session.

Applying appropriate system design principles for online instructional materials directly affects the performance of the learners (Partow-Navid & Slusky, 1999).

Therefore, the design of the WBI course considered the ACTIONS model that was developed by Bates (McIntyre, 1997). According to Bates (McIntyre, 1997), media selection should be based on Access. In this study, the WebCT system showed a high level of accessibility and flexibility. Cost is another important step in Bates's model. Teaching and Learning, the third step, was centered on the learners' needs. Although the design of this instruction was performed by the researcher, it had relevance for the learners as well. The design was flexible enough to allow the learner to have live interaction with the instructor through chatrooms. Also, the use of color, text, the placement of the pictures, and the use of a streaming video were all organized in a way that made sense for the learners. The repeating of certain skills and the magnifying of objects were available for the students at any time during the learning process.

Interactivity, the fourth step in Bates's model was essential in this instructional method. This method ensured the availability of two-way communication between the instructor and the learners and among the learners themselves. Organizational issues were also considered in this method of instruction to give the students a meaningful cognitive structure to encompass the subject matter that followed (Rada, 1998). For example, the learners first accessed a chat-room and then looked at the text and pictures presentation,

including a video clip followed by group discussion. This study assumed that the learners were familiar with Internet navigation. However, when some participants showed a lack of knowledge, a brief introduction for that purpose was given. Lastly, this study ensured that the speed of the computers would not be frustrated because the learners were placed in a computer lab in Matthews Hall (MH 307), which had at least Pentium III computers with high-speed processor 500 MB and RAM of 128 MB, sound cards, and headphones. In addition, these computers were connected to the Internet via T-1 leased line, which speeds up to 1.544 MBPS (Mega Bit/Second). This connectivity did not cause frustration for the participants when they attempted to download the video clips incorporated in this experiment.

Pilot Study

A pilot study was conducted for the purpose of obtaining preliminary information about the distribution of the scores on both of the dependent variables, cognitive and psychomotor learning. Detecting the errors that might have been committed by the researcher was another important reason for conducting a pilot study. More importantly, the pilot study allowed the researcher to test the validity and reliability of the cognitive test and the psychomotor test used in this study.

Because this study used new instruments that measure students' performance on the given subject, the pilot study helped in calculating the appropriate reliability coefficients. These calculations were necessary in terms of understanding the probability and ability of the used instruments to predict the students' new scores.

Some modifications were applied to the checklist (see Appendix K) form used in the study. The items in part A of the checklist form were not clear for the judges. For example, one of the judges was confused about Item 5: Did the student apply enough solder? The judge was wondering about the word enough. Thus, the following change was made regarding this item: Did the student apply solder after applying the heat to fill the joint? Another modification made to the form was related to part B. The items in part B were written in negative form. After the pilot study, the researcher discovered that the items were not consistent with the used scale (yes/no scale). Therefore, proper adjustments were made for that purpose.

The pilot study helped in revealing some spelling mistakes made in the WBI method design. For example, the syllabus page of the web-based method contained the word dam instead of damp. These mistakes would not have been discovered without the conduction of the pilot study. In addition, another major defect in the design of the WBI group was corrected as a result of conducting the pilot study. The mistake was related to the use of streaming video. During the pilot study, the design did not include a streaming video. However, the participants seemed to be lost for the first 7 minutes of the instructional session. The reason was simply that the participants did not know where the starting point was. Therefore, the researcher decided to use a video clip and call it an overview. This overview provided the participants with a clear understanding of what they would be doing during the instruction.

Data Collection Procedure

Six graduate and undergraduate courses in the program of Applied Technology, Training and Development (ATTD) at the University of North Texas were used for the experiment, based on the willingness and cooperation of the instructors. A request for cooperation was sent to all instructors in the ATTD program (see Appendix I). All the equipment (computers, internet connection, software, circuit board kits, tools, safety glasses) was available before the students came in to the classroom. The classes (cluster sampling) were randomly selected and assigned to one of the two instructional treatments.

First, all participants signed an Informed Consent Form (see Appendix C). Each participant received a circuit board kit. This kit includes safety glasses, solder, wire cutters, components, and a plastic circuit board that was not connected to any sort of electricity; it was merely for practicing soldering. After providing these materials, the instructional treatments and a posttest, test and checklist measures were administered. This process took about an hour: 10 minutes were assigned for an introduction and the signing of the Informed Consent Form, 30-minutes for instruction, and 20 minutes for the posttest. Furthermore, demographic data were collected to help describe the sample in the study. Gender, age, major field of study, and work experience were collected immediately after the instruction (see Appendix L).

The data were collected and recorded in the computer for analysis. This experiment took 1 week to be conducted. This period of time was not believed to be too long to contaminate the data; a 1-week period was set to assure that required sample size

was met since some classes met everyday, Monday through Thursday. In addition, there was little possibility that the students would communicate with each other about the treatment because the students' performance was not related to their grades.

Instrumentation

Posttest only was used in the study to assess student cognitive and psychomotor performance. The researcher decided not to conduct a pretest because it would have an influence on the treatment of the study, such as remembering the questions in the pretest. Another reason for not conducting a pretest was that this study involved performance measures, which would intimidate the participants and would turn them away from the experiment, especially if they showed a lack of knowledge and skills in the subject of the course. This is evidenced by Campbell and Stanley's (1966) statement that "while the pretest is a concept deeply embedded in the thinking of research workers in education and psychology, it is not actually essential to true experimental designs" (p. 25).

Because this study was measuring the effects of the two methods (WBI vs. traditional classroom instruction) on cognitive and psychomotor learning, a posttest consisting of two parts was given at the end of each instructional session. These parts were a knowledge-based test (cognitive test) and a performance-based test (psychomotor test). Copies of both parts of the posttest are attached in Appendix J and Appendix K, respectively. The posttest was administered to all subjects immediately after the instruction.

Cognitive Test

Description. The researcher of this study purchased a knowledge-based test on soldering from Electronic Goldmine, an official retailer for Chaney Electronic Company, to measure the students' performance on the cognitive domain of learning. Chaney Electronic Company specializes in selling and developing curriculum and test materials for teachers and educational institutions. Appendix I contains a copy of the test. The test consists of 10 multiple-choice items. Each item has two distracters and one correct answer. The answer keys for the 10 items are also included with the test for the researcher to depend on during the grading process. Some of the items have figures and ask the student to identify the figures and their applications on soldering.

The type of scale used in this test was of type continuous score, which means that the total score was calculated for each subject. The minimum score a student could obtain in this test was 0. The maximum score that a student could obtain in this test was 10, since there were only 10 questions, and each question was worth one point each.

The items in the cognitive test vary from simple recall of information, knowledge level, to higher level of understanding such as analyzing and evaluation, which illustrates the Bloom et al. (1954) classification of the cognitive domain. For example, one of the items asks the student to look at a solder in a figure and select the best answer based on the student's evaluation of the shown soldering joint.

The researcher attempted to improve the face validity of the test by providing clear directions that could help the students understand how to respond to each of the questions. Also, the researcher made some changes to the layout of the items in the test

because there were some mistakes in the design of the test items. For example, one of the items had one space for the correct answer, but the corresponding responses varied; some had one word and others had two words. Thus, the research decided to change the item to make the multiple choices have the same number of words as the number of the spaces provided in the corresponding item. Another change made to the test was that the figures in the test had no number. Although it was clear that the figure corresponded to the item next to it, the researcher decided to add numbers underneath each figure and include that number in the corresponding item.

Validity. Validity is the extent to measure what is supposed to be measured. DeVellis (1991) differentiated among three types of validity: content validity, criterion-related validity, and construct validity. Because this study attempted to measure student achievement on the cognitive test, content validity was most relevant to this test. Content validity refers to the degree to which the scores yielded by a test adequately represent the content, or conceptual domain, which these scores purport to measure (Borg et al., 1996). The knowledge-based test used in this study was assumed to be a valid test because it was designed and developed by subject matter experts in the field of educational electronics, at Chaney Electronic Company. The people who developed the test, also developed the curriculum used in this study. However, because validity is frequently determined by nonstatistical means (George & Mallery, 1999), two subject matter experts, Larry Daniel and Earl L. McCallon, judged the validity of the test. The experts were provided with a copy of the content of the instructional materials used in this study, accompanied with a copy of the test itself. The experts supported that the test was content and face valid.

Reliability. Reliability is a measure of consistency. It refers to how much measurement error is present in the score yielded by the test (Borg et al., 1996). George and Mallery (1999) stated that instruments used in the social sciences are generally considered reliable if they produce similar results, regardless of their administration and forms. The coefficient of internal consistency, alpha coefficient, was calculated for this test. After conducting the pilot study, the data were entered into the SPSS program and a reliability procedure was performed using the following formula:

$$\alpha (\square) = \frac{kr}{1 + (k-1)r}$$

Where, k is the number of items in the scale, and r is the average correlation coefficient between pairs of items.

Psychomotor Test

Description. The researcher of this study developed a psychomotor checklist form for soldering, because there was not such a test/checklist available. Appendix K contains a copy of the checklist form. The intent of this checklist form was to do a process and product assessment of the students' performance after receiving soldering instruction used in this study. Four raters who were trained to evaluate students' performance during and after the treatment used this checklist form. Three raters (judges) were doctoral students in the ATTD program, and one was from the Engineering Technology Department.

The performance test consisted of two parts. Part A was the process assessment containing 10 items. Each item had a Yes or No answer. Such items are called dichotomous (DeVellis, 1991) because they have only two responses options, Yes or No.

According to the directions in this section, the rater observed students' performance while soldering and checked Yes if the student performed the step; otherwise, he/she checked No. The items in this part of the test were constructed based on the sequence of the soldering steps, which were delivered during the instruction. The instruction mainly focused on providing the learners with 10 steps for soldering; this checklist form examined the students' performance on those 10 steps. Part A of the checklist form revealed valuable information on whether or not the participant did the step properly (as learned).

Part B was a product assessment. After the students finished soldering, they turned in all of the circuit boards, which they were working on during the performance test. After that, the judge used the provided student code number, which was stuck on each circuit board and the questions on part B in the checklist form to evaluate final students' performance. This part consisted of 5 items. The items took only a Yes or No answer. Therefore, the rater read the directions, which stated that after turning in the circuit board (products), the rater used the items in part B of the checklist form and started responding to the questions based on the evaluation of the product. Part B of the checklist form revealed valuable information on the quality of student performance.

The scale used in this test was of type continuous score. Each item in the checklist form took either Yes, which was worth 1 point, or No, which was worth 0 point. Hence, since there were 15 items in the checklist form, the maximum score that a student could earn in this test was 15 points, and the minimum score was 0 points.

Validity. Since there were only 10 steps and five cases to recognize bad or good soldering delivered during the instruction, this checklist form was assumed to be content valid because it asked for responses about all of the 10 steps and the five cases in the same sequence in the instruction. However, the researcher selected two excerpts, Larry Daniel and Earl L. McCallon, to judge the validity of this form. They supported that this checklist form was valid.

Reliability. The reliability of the soldering checklist form that was developed by the researcher was also measured. Raters who volunteered for the study used the checklist form to evaluate student performance. Therefore, a specific type of reliability coefficient was used. Such type of reliability is known as interrater reliability. Its coefficient is called interrater coefficient. This coefficient was calculated during the pilot study before conducting the experiment to make sure that a reliable instrument was used. The interrater reliability coefficient among the four judges in this study was .74. This coefficient was considered to be moderately high. However, the researcher attempted to increasing this coefficient by training the judges before the conduction of the experiment and making necessary changes for the items that had low means across raters. Therefore, after the pilot study, all judges received additional training session presented by Brian Urban to help increase the interrater reliability coefficient. The training consisted of 20-minute about evaluating soldering task.

Data Analysis

To carry out the analysis in this research, SPSS for Windows 98 was used. SPSS stands for the statistical package for the social sciences. It was compromised of two

interrelated facts, the statistical package itself and SPSS language, a system of syntax used to exact commands and procedures (George & Mallery, 1999). Thus, Graphical User Interface (GUI) and SPSS programming syntax were used interchangeably to perform the analysis.

First, the data were inserted into the SPSS data editor program. Based upon the results of the posttest, a statistical analysis consisting of a 2 x 2 factorial analysis was administered with an SPSS program for each of the dependent variables. This analysis is commonly referred to as a two-way analysis of variance (ANOVA). “A two-way analysis of variance is a procedure that designates a single dependent variable (always continuous) and utilizes exactly two independent variables (always categorical) to gain an understanding of how the independent variables influence the dependent variable” (George & Mallery, 1999, p. 142). The ANOVA procedure should be used whenever possible for analysis of variance because ANOVA processes data more efficiently than general linear models (GLM). However, GLM should be used in most unbalanced situations; that is, models in which there are unequal numbers of observations for the different combinations of class variables specified in the model. This study adjusted for the samples size (N) because the equal-cell-size was not met.

Hypotheses Discussion

The overall hypothesis of this study was that adult learners’ performance on cognitive and psychomotor objectives delivered via WBI is not significantly different from their performance in the traditional classroom instruction. In addition, the study considered the effects of gender variable on each of the dependent variables only when

interacting with any of the instructional group. Thus, testing the main effects for gender was intentionally ignored by the researcher, and only the interaction effects between gender and methods of instruction were considered in the analysis of the data. Hence, there were four hypotheses to test in this study:

1. Adult learners' achievement on cognitive objectives delivered via WBI is not significantly different from that in traditional classroom instruction.

$$H_{01}: \mu_{\text{WBI}} = \mu_{\text{TCI}}$$

Hypothesis 1 is a test of main effect, in two-way ANOVA, for the methods of instruction used in this study. That is, do adult learners in the two methods of instruction differ significantly in their achievement in the cognitive learning, and which method scored higher than the other?

2. There is no significant interaction effect between gender and methods of instruction (WBI vs. traditional classroom instruction) on cognitive objectives.

$$H_{02}: \mu_{\text{gender}} = \mu_{\text{methods}}$$

Hypothesis 2 is a test of the interaction effect between gender and methods of instruction. In other words, is the effect of the two independent variables, gender and methods of instruction, idiosyncratic? That is, one level in the gender variable has different effects across levels in the methods of instruction variable.

3. Adult learners' performance on psychomotor objectives delivered via WBI is not significantly different from that in traditional classroom instruction.

$$H_{03}: \mu_{\text{WBI}} = \mu_{\text{TCI}}$$

Hypothesis 3 is a test of main effect, in two-way ANOVA, for the methods of instruction used in this study. That is, do adult learners in the two methods of instruction differ significantly in their performance in the psychomotor learning, and which method scored higher than the other?

4. There is no significant interaction effect between gender and methods of instruction (WBI vs. traditional classroom instruction) on psychomotor objectives.

$$H_{04}: \square_{\text{gender}} \square \square_{\text{methods}}$$

Hypothesis 4 is a test of interaction effect between gender and methods of instruction. In other words, is the effect of the two independent variables, gender and methods of instruction, idiosyncratic? That is, one level in the gender variable has different effects across levels in the methods of instruction variable.

Summary

The study aimed at measuring the effects of web-based instruction on cognitive and psychomotor learning. The study utilized the graduate and undergraduate students (adult learners) enrolled in summer classes in the ATTD program at the University of North Texas as the target population, to deliver a 30-minute instructional session to measure their cognitive and psychomotor learning. The sample was chosen based on the willingness and cooperation of the instructors. This sampling procedure is recognized as cluster sampling because the selection was for classes (groups of individuals), not individuals.

This study compared two methods of instruction, web-based instruction versus traditional-classroom instruction. These two levels of methods of instruction constituted one independent variable. Another independent variable in this study was gender. This variable contained two true dichotomies, male and female students.

The design of the research was a posttest-only control group design. Therefore, the data collection procedure consisted of only a posttest that was administered to all subjects immediately after instruction. The results were analyzed by conducting Two-way ANOVA procedure for each of the dependent variables, cognitive and psychomotor.

CHAPTER 4

FINDINGS

This chapter describes the analysis and interpretation of data generated by testing hypotheses that examine the impact of web-based instruction (WBI) on cognitive and psychomotor learning. First, the data are described. Second, statistical analysis of the results in the experiment is presented. Third, the main effects and the interaction effects of pertinent variables with cognitive learning and psychomotor learning are evaluated and discussed. Finally, each hypothesis, as presented in chapter 3, is identified, along with supporting analysis and discussion.

The population was 50 graduate and undergraduate students enrolled in summer classes offered by the Applied Technology, Training and Development (ATTD) program at the University of North Texas. The sampling procedure used in this study was cluster sampling, because choosing groups of individuals was more convenient for the purpose of this study. The sample consisted of 46 randomly selected students, 23 in the control group and 23 in the treatment group. The treatment group was given instruction on the web, and the control group was given instruction in a traditional way. In the treatment group, instructions were provided via the web. Subjects were asked to access the course web site hosted on the Webct system at the University of North Texas. The subjects utilized the chat room to interact with the instructor at distance. Instructions in the control group, however, were delivered utilizing traditional methods of teaching, such as demonstrations and illustrations of soldering techniques. The students were compared in

the four null hypotheses presented in chapter 3. All of the hypotheses were tested using two-way analysis of variance (ANOVA).

Data Description

In the current study, two main domains were assessed, cognitive and psychomotor domains. Data in the cognitive domain were obtained via a cognitive test administered by the examiner; data in the psychomotor domain were obtained via observation by trained raters. All participants in this study started the experiment; one of them used her right to withdraw from the study. Therefore, not all data were used in the analysis. Some demographic information such as educational level, gender, age, student major, and past work experience with soldering a circuit board were collected during the conduction of this study; (see Appendix L). However, not all of the demographic data were used in the analysis; only the variables that were pertinent to the nature of the study (as shown in the Literature Review chapter) were employed in subsequent analysis.

Validity and Reliability of the Instruments

Two forms of performance measure were administered at the end of each instructional session. One was a knowledge-based test used to assess students' cognitive skills. The other measure was a performance checklist. Both measures were used as posttest only. They were tested for content and face validity by experts specialized in measurement and educational research design. Reliability coefficients were calculated two times for each of the measures. Table 5 summarizes the coefficients for each of the performance measures used in this study, one of which was calculated during the pilot study and one during the actual experiment.

Table 5

Summary of the Reliability Coefficients for Each of the Performance Measures

	Pilot study	Actual experiment	Type of reliability Coefficient
Cognitive test	.7513	.8179	Alpha coefficient
Performance checklist	.7412	N/A	Interrater coefficient

Table 5 indicates the reliability coefficient for the both of performance measures used in this study. As shown in Table 5, the alpha coefficient was calculated for the knowledge-based test that measures students' ability to gain cognitive objectives. During the pilot testing, the alpha coefficient was .75. As a rule of thumb, .75 is considered to be strong (Hinkle at al., 1998). However, the research made some modifications as explained in chapter 3 to improve the reliability of this instrument. When testing this coefficient again in the actual experiment, the coefficient was slightly increased to become .81. This is also considered to be a strong reliability coefficient.

The interrater reliability coefficient was also calculated during the pilot study, but not in the actual experiment. Due to time constraints, the researcher set up this experiment to have different judges. With each judge evaluating different subjects. Since the intention of this study was to use different raters to minimize the time required to observe and evaluate each of the subjects, recalculating the interrater reliability was inapplicable. Thus, the reliability coefficient that was calculated during the pilot study, as

shown in Table 1, was .7412. This is considered to be a moderately strong reliability coefficient.

Description of the Sample

Among the 46 participants, 42 were from in the College of Education; 30 from the Applied Technology, Training and Development Program; 11 from the Computer Education and Cognitive System Program; and 1 student was from the Elementary Education Program. The remaining 4 students were from other program areas at the University of North Texas. Table 6 shows the field of study for all participants.

Table 6

Fields of Study of Subjects

	Frequency	Percent	Cumulative percent
ATTD	30	65.2	65.2
CECS	1	2.2	67.4
EDEE	11	23.9	91.3
Others	4	8.7	100
Total	46	100	

Because this study involved graduate and undergraduate students enrolled in classes in the ATTD program, frequencies of these data would help describe the sample. Twenty-nine participants (63%) were graduate students (see Table 7). Seventeen participants (37%) were undergraduate students.

Table 7

Educational Level of Subjects

	Frequency	Percent	Cumulative percent
Graduate	29	63	63
Undergraduate	17	37	100
Total	100	100	

The ages of the subjects in this study ranged from 18 years to 45 or older. Table 8 contains frequency and percentage of ages of all subjects. The largest number of subjects falls into the category 26-35, which constituted 39.1 of the entire sample.

Table 8

Age of Subjects

	Frequency	Percent	Cumulative percent
18-25	7	15.2	15.2
26-35	18	39.1	54.3
36-45	12	26.1	80.4
45+	9	19.6	100
Total	46	100	

In terms of gender, 20 males and 26 females constituted the sample of this experiment (see Table 9).

Table 9

Gender of Subjects

	Frequency	Percent	Cumulative percent
Male	20	43	43.5
Female	26	56.5	100
Total	46	100	

Because this study did not conduct a pretest to assess participants' performance with soldering a circuit board, obtaining data about the previous experience with soldering a circuit board was essential for the study. Table 10 shows whether or not a previous experience with soldering experience exists. If so, the table provides further details about how long in the past that experience existed.

Table 10

Previous Experience With Soldering a Circuit Board

	Frequency	Percent	Cumulative percent
No experience	37	80.4	80.4
Recently*	0	0	80.4
1-3 years ago*	5	10.9	91.3
4-5 years ago*	2	4.3	95.7
5+ years ago	2	4.3	100
Total	46	100	

* Denotes that subjects in these categories were eliminated from the analysis.

Table 10 indicates that 37 participants (80.4%) had no previous experience with soldering a circuit board. Table 10 also shows the percentage of subjects who had previous experience with working with soldering tasks.

None of the participants showed a recent experience with soldering a circuit board. Only 10.9% of the entire sample had had previous experience between 1-3 years ago, and 4.3% between 4-5 years ago. Of the participants, 4.3% had experience with soldering a circuit board in more than 5 years ago. Hence, 7 participants in this study were eliminated from the analysis because they had previous experiences with soldering a circuit board within the last 5 years. Therefore, this elimination reduced the number of subjects used in the analysis from 46 to 39.

At the beginning of the experiment, each of the control and experimental groups contained 23 subjects. However, 1 participant in the experimental group (WBI) used her

right to withdraw and discontinued the experiment. Consequently, the final total number of subjects used in the analysis in this experiment was reduced from 46 to 38.

Table 11 shows the valid number of subjects in each of the groups in this experiment. The experimental group, WBI had 20 participants. The control group, traditional method of instruction, was made up of 18 participants. Noticeably, the two groups were not equal in size. Therefore, appropriate adjustment for the unequal N size between the cells in ANOVA was made during the analysis.

Table 11

Number of Subjects in Each of Method of Instruction

	Frequency	Percent	Cumulative percent
WBI	20	53.8	53.8
Traditional	18	46.2	100
Total	38	100	

Dependent Measures

The dependent variables were cognitive learning and psychomotor learning, as measured by the knowledge-based test scores and the checklist form scores, respectively.

Cognitive learning. Knowledge-based assessment was used to measure students' cognitive skills in soldering a circuit board. The assessment device consisted of a 10-item multiple-choice test. Each question was worth 1 point. Thus, the highest a subject could

earn in this test was 10 points; the lowest was 0 points. Appendix J contains a copy of this test.

The distribution of the subjects' scores is illustrated in Figure 8. The figure indicates that 10 points was the highest achieved score in the cognitive learning test, and 4 points was the lowest score. Almost 50% of the participants in both groups scored 8 points in the cognitive test.

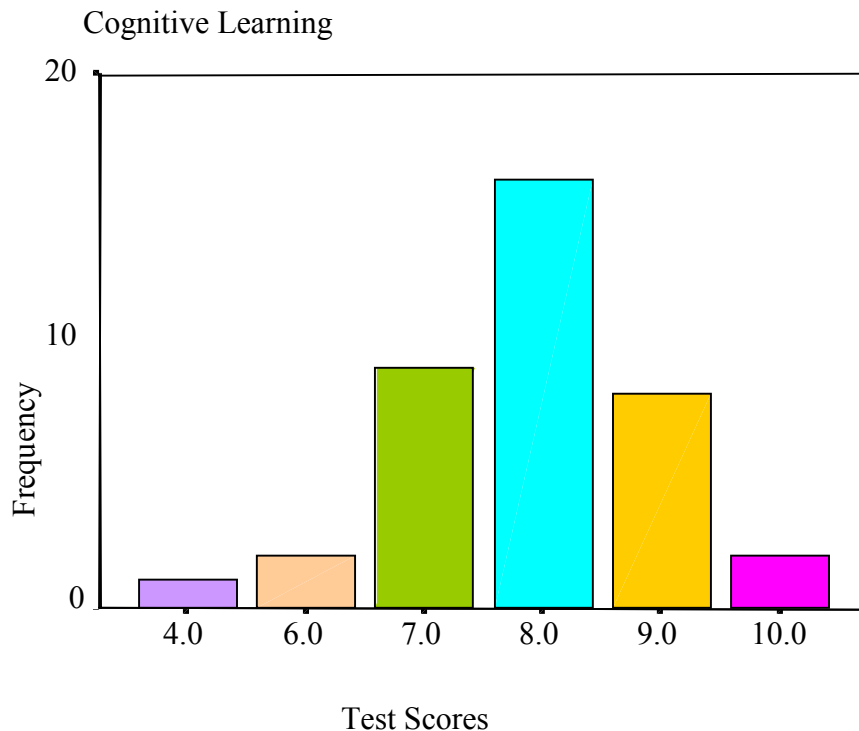


Figure 8. Distribution of subjects' scores on the cognitive learning.

Means and standard deviations of the test scores, along with the number of subjects for gender and method of instruction, are presented in Table 12. The mean score for the WBI group, as shown in Table 12, was 7.8. The total mean score for the traditional group was 7.94.

Table 12

Means, Standard Deviations, and Frequencies of Scores of Subjects in Cognitive Learning

	WBI			Traditional		
	<u>M</u>	<u>SD</u>	<u>n</u>	<u>M</u>	<u>SD</u>	<u>n</u>
Male	8.29	.76	7	8.6	.55	5
Female	7.53	1.39	13	7.70	1.11	13
Total	7.80	1.24	20	7.94	1.06	18

Note. M= Mean Score; SD= Standard Deviation; n= number of subjects in cell.

Based on sample size requirements, as discussed in chapter 3 (Hinkle et al., 1998) and shown in Table 12, most of the cells satisfied the requirement of cell size. There was a little shortage of males; however, this did not have an overall impact on the analysis. It was judged that the total sample size of 38 was sufficient to carry on with testing the experimental hypotheses (Hinkle et al., 1998). Since no hypothesis concerned the main effect of gender, it was supposed that this shortage would not hamper the findings of the study.

Psychomotor learning. A performance checklist was used to measure students' psychomotor skills on soldering a circuit board. It contained 15 items (yes/no checklist form) divided into process assessment and product assessment. Each item was worth one point. Trained judges used this form to evaluate subjects' performance while performing the soldering task.

The distribution of the subjects' scores on the psychomotor learning is illustrated in Figure 9. The figure shows that 5 participants of the entire sample received the maximum score of 15 points. Only 1 received 4 points, which was the lowest achieved score in the performance checklist in this experiment.

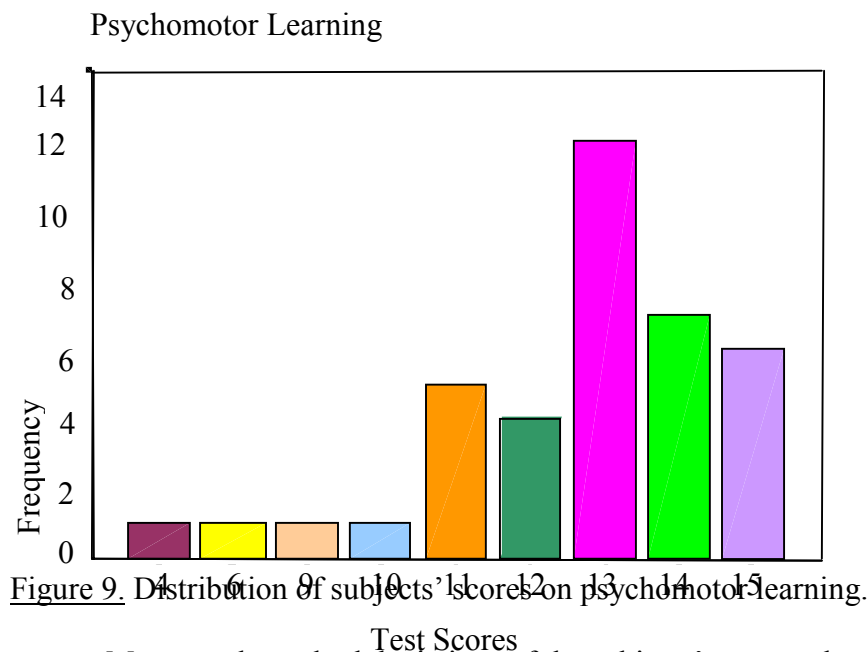


Figure 9. Distribution of subjects' scores on psychomotor learning.

Means and standard deviations of the subjects' scores, along with the number of subjects for each of the independent variables (gender and instructional methods) are presented in Table 13. The total mean score for traditional group ($\underline{M} = 13.39$), as shown

in Table 13, scored higher the WBI group (\underline{M} = 11.75). The males (\underline{M} = 12) scored higher than the females (\underline{M} = 11.62) in the WBI group.

Table 13

Means, Standard Deviations, and Frequencies of Scores of Subjects in Psychomotor Learning

	WBI			Traditional		
	<u>M</u>	<u>SD</u>	<u>n</u>	<u>M</u>	<u>SD</u>	<u>n</u>
Male	12	1.15	7	13.40	1.14	5
Female	11.62	3.36	13	13.38	1.50	13
Total	11.75	2.75	20	13.39	1.38	18

Note. M= Mean Score; SD= Standard Deviation; n= number of subjects in cell.

Statistical Analysis

The analysis in this experiment concentrated on the comparisons between the control group and the experimental group on cognitive testing and psychomotor observation. Using SPSS version 9.0, a two-way ANOVA was conducted comparing knowledge test scores and performance scores between the control and the treatment

groups. The advantage of this type of factorial analysis includes a) efficiency, b) control over additional variables, and c) the study of the interaction among independent variables (Hinkle et al., 1998).

For the full model of two-way ANOVA, there are generally three null hypotheses to be tested; one for the gender effect, one for the treatment effect, and one for the treatment by gender interaction. However, the four hypotheses in this experiment concerned the main effects for method and gender by method interaction. The main effect of gender was not considered to be prominent in the current study. Thus, the main effect for the gender variable was not hypothetically tested in this experiment, since this study was not intended to measure the effect of gender variable on cognitive or psychomotor learning. However, the analysis considered the interaction of the levels of gender variables across the levels of the method variable on each of the two learning domains of interest to this study. Therefore, in this experiment, the customized data analysis model was run for each of the dependent variables, cognitive and psychomotor learning.

Analysis on the Cognitive Measure

Table 14 is a result for a test of between-subjects effects (SS_B) in two-way ANOVA. The table includes results for a test for main effect (method) and a test of the interaction effect (Interaction) between the two independent variables in this study, gender and methods of instruction in cognitive learning. The main effect for method was not statistically significant ($F(1, 34) = .35, p = .557$). In addition, the method by gender interaction was also not statistically significant ($F(1, 34) = .04, p = .840$).

Table 14

Summary ANOVA for Cognitive Learning

	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	<u>Sig.</u>
Method	.44	1	.44	.35	.557
Gender	5.51	1	5.51	4.40*	.043
Interaction	5.18E ⁻⁰²	1	5.18E ⁻⁰²	.04	.840
Error	42.63	34	1.25		
Total	48.63	37			

Note. SS= Sum of square; df= degree of freedom; MS= Mean square; F= computed F value; Sig.= Level of significance.

* Denotes statistical significance at .05 level of significance.

Analysis on the Psychomotor Measure

A test of between-subjects effects (SS_B) in two-way ANOVA was performed, as shown in Table 15. The table includes results for a test for main effect (method) and a test of the interaction effect (interaction) between the two independent variables in this study, gender and methods of instruction in psychomotor. Again, the gender by method interaction was not statistically significant ($F(1, 34) = .053$, $p = .819$). However, the main effect for method approached statistical significance ($F(1, 34) = .392$, $p = .056$).

Table 15

Summary ANOVA for Psychomotor Learning

	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	<u>Sig.</u>
Method	20.22	1	20.22	3.92	.056
Gender	.32	1	.32	.06	.804
Interaction	.27	1	.27	.05	.819
Error	175.35	34	5.16		
Total	201.47	37			

Note. SS= Sum of square; df= degree of freedom; MS= Mean square; F= computed F value; Sig.= Level of Significance.

Strength of Association

As shown in Table 14, a significant F statistic indicates that some relationship existed between the dependent variable (cognitive learning) and the independent variable (method of instruction). Although this information was useful, it does not provide information about the strength of association between the dependent variable and the independent variable. Hinkle et al., (1998) suggested the most popular measure of strength of association, omega squared (ω^2), for fixed treatment effects in ANOVA. They presented the formula for calculating omega squared as follows:

$$\omega^2 = \frac{SS_B - (K-1)MS_w}{SS_T}$$

$SS_T + MS_w$

Figure 10. Measure of association formula.

Applying the above formula in Figure 10 to data in Table 14, omega squared equals

$$\omega^2 = \frac{.44 - (2-1)(1.25)}{48.34 + (1.25)} = .02$$

This means that the two methods of instruction, the independent variable in the ANOVA, account for about 2 % of the variance in cognitive learning, the dependent variable. The psychologist would interpret this as a small association between method of instruction and cognitive learning.

Table 15 also shows a significant F statistic, which indicates that some relationship existed between the dependent variable (psychomotor learning) and the independent variable (method of instruction). Therefore, a measure of association, omega squared, was also necessary to provide useful information about the association between the dependent variable and the levels of the independent variable (Hinkle et al., 1998).

Applying the above formula in Figure 10 to data in Table 15, omega squared equals

$$\omega^2 = \frac{20.22 - (2-1)(5.16)}{201.47 + (5.16)} = .10$$

This means that the two methods of instruction, the independent variable in the ANOVA, account for about 10 % of the variance in the psychomotor learning, the dependent variable. The psychologist would interpret this as a small but notable association between method of instruction and psychomotor learning. Therefore, this should be considered when interpreting the main effect for method in testing psychomotor skills. Omega squared for the interactions were .001 and .002 in the cognitive and psychomotor domains, respectively.

Power Analysis

The power of the treatment effects test was analyzed using SPSS for each of the dependent variables, as shown in Table 16 for the cognitive learning and Table 17 for the psychomotor learning. Power is the probability of rejecting a null hypothesis when it is in fact false (Hinkle et al., 1998). In other words, power of a test explains the probability of the statistical analysis to find significance, if there is any.

Table 16 shows that the power of a test for instructional methods is 0.09; 9 times out of 100 the statistical procedures will be capable of detecting the significant difference between traditional classroom instruction and web-based instruction when involved in learning a cognitive task. Table 16 also shows that the probability of rejecting the null hypothesis for interaction effects between gender and method of instruction is 5 % if the interaction effect exists in the population.

Table 16

Power and ES Calculations for Treatment Effect in Cognitive Learning

Treatment	Effect size	Power of test	Confidence	Confidence
			interval: Lower	interval: Upper
			limit	limit
Method	.01	0.09	-1.05	.74
Gender	.16	0.5	-.15	1.77
Method*Gender	.001	0.05	-1.5	1.25

Note. Type I Error rate = 0.05; Sample size = 38.

Table 17 shows that the power of a test for instructional methods is 0.49; 49 times out of 100 the statistical procedures will be capable of detecting the significant difference between traditional classroom instruction and web-based instruction when one is involved in learning a cognitive task. Table 17 also shows that the probability of rejecting the null hypothesis for interaction effects between gender and method of instruction is 6 % if the interaction effects exist.

Table 17

Power and ES Calculations for Treatment Effects in Psychomotor Learning

Treatment	Effect size	Power of	Confidence	Confidence
		test	interval: Lower limit	interval: Upper limit
Method	.01	0.49	-3.48	-6.01E-02
Gender	.002	0.06	-1.72	1.95
Method*Gender	.002	0.06	-1.92	3.35

Note. Type I Error Rate = 0.05, Sample Size = 38

Hypotheses Testing

Based upon the results in the previous statistical analysis, the hypotheses stated in chapter 3 were tested. The hypotheses were stated in terms of relationships between methods of instruction and each of the two dependent variables, cognitive and psychomotor learning, and the interaction effect of methods of instruction and gender on the same dependent variables.

Hypothesis 1

H₀₁: Adult learners' performance on cognitive objectives delivered via WBI is not significantly different from that in traditional classroom instruction.

This hypothesis was proposed to test whether adult learners would vary in cognitive learning when faced with different methods of instruction. Based upon the data collected

and analyzed in Table 14, H_{01} is retained at a significant level of 0.05, $F = .35$, $p = .557$. This suggests that the traditional method and web-based method of instruction produce similar effects in cognitive learning.

Hypothesis 2

H_{02} : There is no significant interaction effect between gender and methods of instruction (WBI vs. traditional classroom instruction) on cognitive learning.

This hypothesis was proposed to test whether students' cognitive learning scores would vary with interactions between different methods of instruction and gender type. It is a test of interaction effect between gender and methods of instruction. In other words, is the effect of the two independent variables, gender and methods of instruction, idiosyncratic? That is, one level in the gender variable has different effects across levels in the methods of instruction variable.

Based upon the data collected and analyzed in Table 14, H_{02} is retained at a significant level of 0.05, $F = .04$, $p = 0.84$. This suggests that there was not enough evidence to find a significant difference in the interaction between gender and method of instruction in cognitive learning. In other words, there is no evidence to support the statement that the traditional method and web-based method of instruction produce different effects across males and females when gaining cognitive objectives. The probability that the observed difference between methods of instruction and gender would have occurred by chance, if in fact the null hypothesis were false, is greater than .05 ($p > .05$). Figure 11 illustrates the finding in this hypothesis.

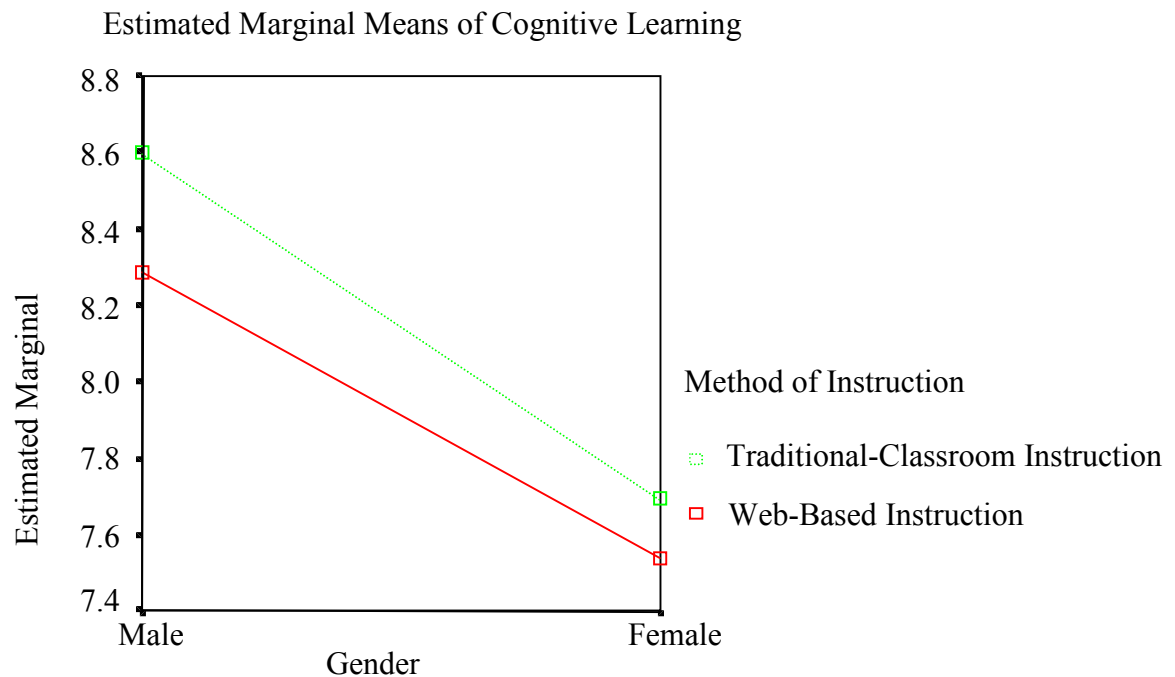


Figure 11. Interaction effects in cognitive learning.

Hypothesis 3

H₀₃: Adult learners' performance on psychomotor objectives delivered via WBI is not significantly different from that in traditional classroom instruction.

This hypothesis was proposed to test whether adult learners would vary in psychomotor learning when faced with different methods of instruction. Based upon the data collected and analyzed in Table 15, H₀₃ was retained at a significant level of 0.05, $F = 3.92$, $p = .056$. This suggests that the traditional method and web-based method of instruction produce similar effects in psychomotor learning. However, the notable effect

size (.10) and fairly low power (.49) suggest that in a larger sample size this testing may be statistically significant.

Although there was not a statistical significance, the traditional group scored higher than the WBI group, as shown in Figure 12.

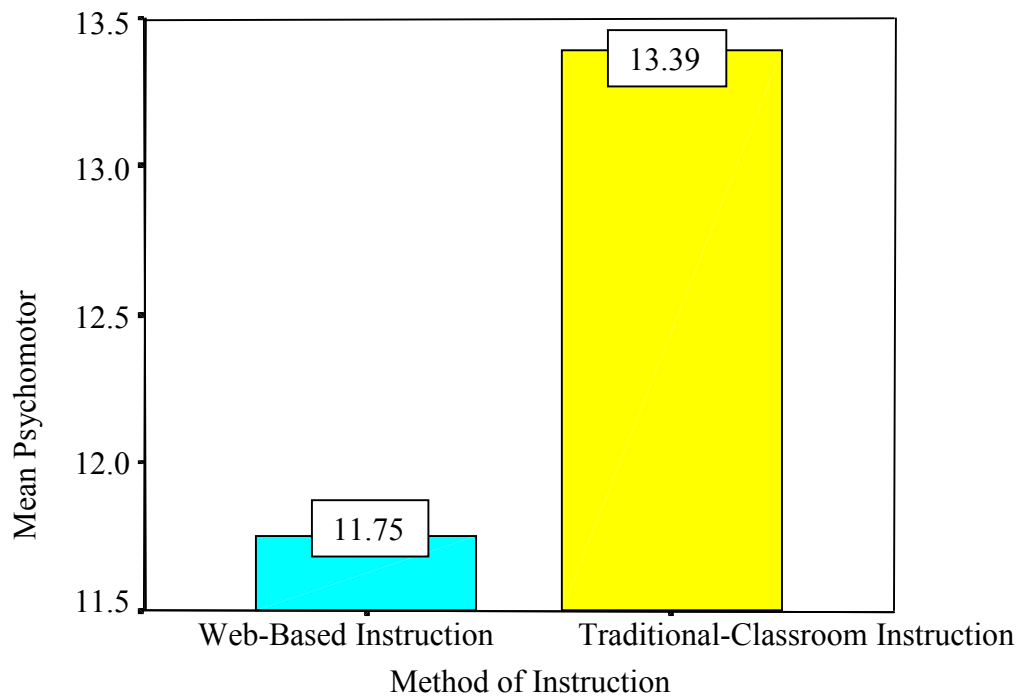


Figure 12. Comparison of means scores (Method) in psychomotor learning.

The mean score for the traditional group was 13.39, whereas the mean score for the WBI group was 11.75. However, the traditional method has not been found to be statistically more effective than the WBI method in this experiment.

Hypothesis 4

H₀₄: There is no significant interaction effect between gender and methods of instruction (WBI vs. traditional classroom instruction) on psychomotor learning.

This hypothesis was proposed to test whether students' cognitive learning scores would vary with interactions between different methods of instruction and gender type. From Table 15, the F ($F = .04, p = 0.804.$) value for the method of instruction variable showed no statistically significant difference at $\alpha = .05$. Therefore, the null hypothesis (H₀₄) is retained, and the conclusion is that the levels of the methods of instruction when interacted with gender variable produce the same results for the psychomotor learning. This indicates that the traditional method and the web-based method of instruction produce similar effects across males and females when gaining psychomotor objectives.

Another way to examine the interaction between the two factors (independent variables) in this study was constructing interaction plots. The lines connecting the means in the interaction plots will be almost parallel (within sampling fluctuation) when a nonsignificant interaction is found in a two-way ANOVA (Hinkle et al., 1998). Figure 13 shows the interaction plots for H₀₄.

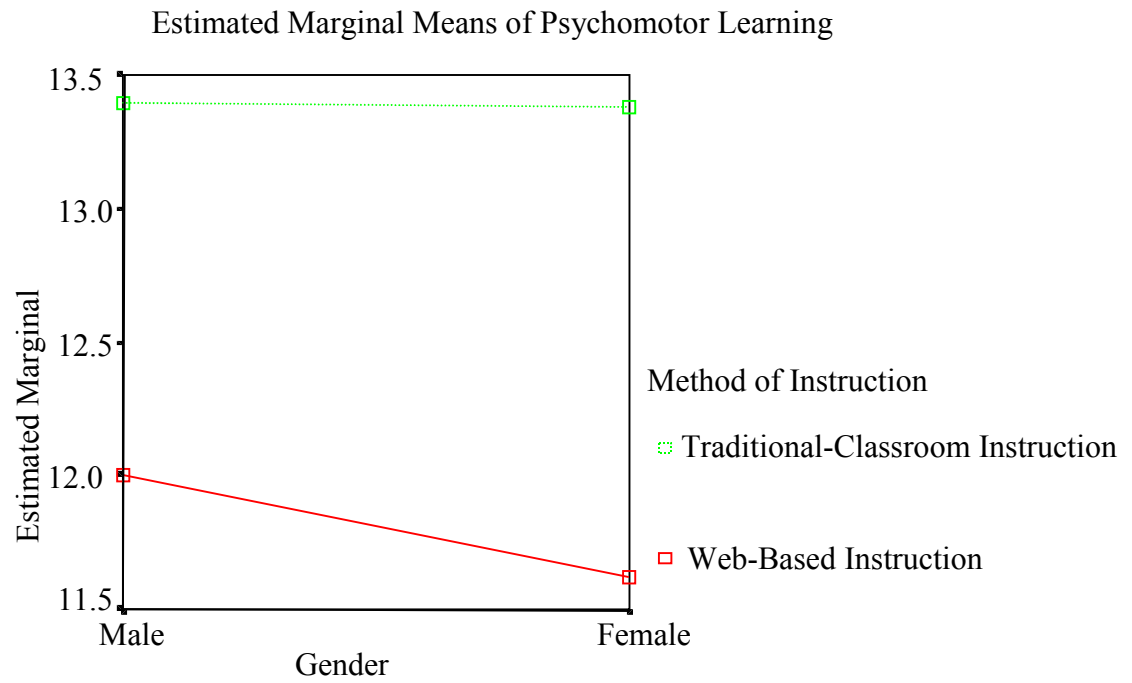


Figure 13. Interaction effects in psychomotor learning.

Summary

Forty-six subjects were randomly selected for this experiment; only 38 were used in the analysis. The four hypotheses in this study were analyzed utilizing two-way ANOVA. Table 18 provides a summary of the results in this study.

Table 18

Summary of Hypotheses Testing

Hypotheses	<u>P</u> -value	Decision
H ₀₁ : There is no significant interaction effect between gender and methods of instruction (WBI vs. traditional classroom instruction) on cognitive objectives.	.557	Retained
H ₀₂ : There is no significant interaction effect between gender and methods of instruction (WBI vs. traditional classroom instruction) on cognitive objectives.	.840	Retained
H ₀₃ : Adult learners' performance on psychomotor objectives delivered via WBI is not significantly different from that in traditional classroom instruction.	.056	Retained
H ₀₄ : There is no significant interaction effect between gender and methods of instruction (WBI vs. traditional classroom instruction) on psychomotor objectives.	.819	Retained

Note: All tests are based on a significance level of .05.

CHAPTER 5

SUMMARY, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

This chapter provides a brief summary of the study, discusses the results of the study, and offers some conclusions and recommendations.

Summary

The purpose of this study was to investigate the effects of web-based instruction (WBI) on cognitive and psychomotor learning for adult learners. The overall hypothesis of the study was that WBI is an effective method of instructional delivery and specifically has the ability to deliver cognitive and psychomotor objectives. Other goals of this study were to determine the relevance of the WBI method and to recommend areas for further study. The study was prompted by the number of organizations that have moved toward the trend of web-based training as a solution to issues of immediacy, convenience, and consistency.

An extensive review of literature was conducted to fully investigate research on WBI intervention. A study of particular note was the work of Bloom et al. (1954), “Taxonomy of Educational Objective.” Bloom’s taxonomy formed the foundation of many later works in the field. Abernathy (1999a, 1999b, 1999c), Driscoll (1997), and Hall (1997) provided an excellent revision of effective web-based training methods. These works (Chapter 2) formed the foundation of the knowledge base of adult learners

to acquire cognitive, psychomotor, and affective skills delivered via the web. Ashe and Buell (1998), Azarmrsa (1993), McIssac (1998) presented findings that proved helpful in the ability of effectively delivering online instructions, especially when used in business, military training, and adult learning situations.

This study examined a cluster sample of 46 participants chosen from a population that consisted of graduate and undergraduate students enrolled in summer courses offered in the program of Applied Technology, Training and Development (ATTD) at the University of North Texas. Subjects were randomly assigned to the control and treatment groups each consisting of 23 students. The researcher collected data regarding whether or not a previous experience with soldering a circuit board existed. If so, subjects who had had soldering experience within the last 5 years were eliminated from the analysis. Additionally, because the groups were randomly assigned to the control and treatment groups, it is evident that the two groups were similar at the beginning of the experiment.

The independent variables used in this study were method of instruction and gender. The dependent variables used were cognitive and psychomotor learning. Therefore, two forms of measurements were used: knowledge-based test and performance checklist. Each was tested for validity and reliability.

The participants received a 30-minute instructional session in order to later measure their ability to achieve cognitive and psychomotor objectives. Two methods of instruction were compared: web-based instruction and traditional methods of instruction. The participants were divided into two groups: one group received instruction via the web (experimental group), whereas the other group received traditional instruction

(control group). The study also investigated the effects of WBI on cognitive and psychomotor learning for both male and female students.

Discussion of Findings

Four null hypotheses were formulated to determine the effectiveness of WBI to deliver instruction for cognitive and psychomotor learning. Two hypotheses were formulated to measure the ability of the web to deliver for cognitive learning, while the other two concerned the psychomotor domain.

First, hypothesis 1 stated that students would not score differently on tests of cognitive learning if instruction were delivered via the web compared to the traditional methods of instruction. Since the p value ($p = .55$) was larger than the established level of significance ($\alpha = .05$), the result would be that no statistically significant difference existed in cognitive learning between the two methods of instruction (web vs. traditional). Therefore, Hypothesis 1 was retained, meaning that the current study could not provide enough evidence to state that the traditional group was different from the web group in achieving cognitive objectives, nor to state that one of the group performed better than the other group. Perhaps, the subjects used in this experiment had a previous knowledge about the given subject matter of this study, a simple soldering task. Another possible reason that this study could not provide evidence that the two groups were different on cognitive learning is that the questions in the cognitive test were too easy for students enrolled in ATTD classes. Also, the multiple choice format of the cognitive test allowed for random guessing, since there was only one correct answer among three possible responses. Another important factor that may have contributed to the acceptance of this

hypothesis was the time chosen to conduct the experiment. Conducting this experiment during the summer semester, resulted in a smaller number of students available for this study. A smaller pool of subjects undercuts the randomization process. However, the finding in this hypothesis is supported by a previous study conducted by Driscoll (2000, 1998) at Teachers College, Columbia University. She found that WBI was an effective method of instruction for teaching on the cognitive domain. In addition, many experimental studies outlined by Merisotis and Phipps (1999) suggest that students in distance learning programs achieve as well as students in traditional classroom instruction. Other studies show that online learning programs are perceived equally with traditional methods of instruction (O'Malley, 1999). Findings in another study by Partow-Navid and Slusky (1999) indicate that teaching at distance is as effective as traditional instruction. In addition, A. E. Barron and Orwig (1997) reported the results of several empirical research studies that found significant positive effects of multimedia instruction on students' achievement.

Although the result of hypothesis 1 in this study showed no significant difference between WBI and traditional-classroom instruction on cognitive learning, the strength of the association between cognitive learning and methods of instruction showed a small association ($\omega^2 = .01$). This indicates that there is little variation on the cognitive learning variable attributed by variations in the method of instruction variable. Therefore, there could be other variables, which determine the effectiveness of the web as an instructional method of delivery on both cognitive and psychomotor learning. For example, the time taken to complete a learning task is a critical variable that can provide valuable

information about the ability of the web medium to deliver cognitive or psychomotor learning. Other variables such as learning styles, educational level, and work experience may provide different results if considered in this study. Participants' learning styles could have been diagnosed and accommodated in advance. For example, a participant who tends to learn visually may face difficulty with Interaction through chat rooms. This process controls for other extraneous variables that could have affected the results of this experiment.

Second, hypothesis 2 stated that there would be no significant difference in levels of methods of instruction (WBI and traditional) on cognitive learning across males and females. Since the p value ($p = .84$) was higher than the already established level of significance ($\alpha = .05$), the result was that no statistically significant interaction effects existed between the levels of methods of instruction (WBI and traditional-classroom instruction) and the levels of gender (male and female) on cognitive learning. Thus, hypothesis 2 was retained, meaning that learning via the web or learning in a traditional way is not influenced by gender type. However, due to the smaller number of males than females, the results may not be applicable to similar experiments consisting of a larger number of males. The present study showed that males had a higher mean score ($\bar{M} = 8.29$) than females ($\bar{M} = 7.53$) when receiving instruction via the web. Perhaps, females did not like the given subject matter (soldering a circuit board), which may have resulted in their lower performance. Perhaps male learners had a higher level of previous knowledge about the subject matter than the females.

Third, in regard to the psychomotor domain, hypothesis 3 stated that students would not score differently on measures of psychomotor learning when instruction is delivered via the web as opposed to the traditional methods of instruction. Because the p value ($p = .056$) was slightly larger than the previously established level of significance ($\alpha = .05$), hypothesis 3 was retained. This indicates that there is no statistically significant difference between traditional method of instruction and WBI in teaching psychomotor skills. In other words, adult learners who received instruction in a traditional way to gain psychomotor objectives scored as well as those who received instruction via the web. This result was surprising. In a similar study that was conducted by Driscoll (2000), WBI was not found to be a suitable method to teach psychomotor skills. This discrepancy shows a conflicting finding in this study.

However, as shown in chapter 4, hypothesis 3 was almost significant and had a notable effect size (.10) and a fairly low power (.49). This implies that the test was not powerful enough to detect a .10 difference between the traditional group and the web group; increasing the sample size would increase the power of the test. If the power of the test were increased, it would be more likely that a significant difference between the two groups would be found (Hinkle et al., 1998). Furthermore, the p value (.056) shows that the test was almost significant at .05 level. Thus, although this test was not statistically significant, it reveals a trend in delivering psychomotor skills; the web is not as effective as delivering cognitive skills when compared with traditional methods of instruction. Another factor that may have reduced the significant difference in this hypothesis was the relationship between the finding in hypothesis 1 and the finding in hypothesis 3. The

literature in chapter 2 revealed that the cognitive and psychomotor domains are mutually dependent, meaning that one learning domain affects the other. Therefore, factors reducing the statistically significant difference in the cognitive domain may have resulted in a lower statistically significant difference in the psychomotor domain. In support of this discussion, previous research studies conducted by Akhtar (1976) support that the type of knowledge received greatly affects motor learning.

The use of text only as an interaction element in the WBI group may have influenced the finding in the psychomotor domain. The result could have been different if there were better choices for interaction elements between the learners and the instructor. Indeed, the design of the WBI method would have enhanced students' psychomotor learning if text (chatting) were used less, which could be replaced with other elements such as audio, video, or animation. Previous research, such as the study conducted by Clay's (1999), found that text was not a preferred element to use on the web, especially when there are other elements that can effectively do the same job. In addition, Driscoll (1998) outlined the disadvantage of using Internet Relay Chat (IRC) in WBI systems. IRC penalizes poor writers, can make conversation disjointed, and lacks nonverbal communication and emphasis. Perhaps the use of a facilitator would increase the level of interaction between the instructor and the learners as well as among the learners themselves. The facilitator's job is different from the assistant's job because the assistant in this experiment was limited to technical and preparation issues. For example, the assistant (lab monitor) attempted to prepare the soldering kit, supply the needed tools, disseminate tests, and assist learners with computing difficulty; however, the assistant did

not answer questions related to the learning topic. Therefore, the availability of a facilitator during instruction via the web would enhance the learning process. Indeed, when the learners face difficulty following the instructor on a certain point, they can always rely on the facilitator, who can either answer the question or direct the student to a place in the curriculum to find an answer. Also, the availability of a facilitator can increase the level of interaction between the instructor and the students, especially when using text as an interaction element, by rewording the student's question or asking the student to state that question verbally to the facilitator. In turn, the facilitator can forward this question to the instructor. Moreover, the availability of a facilitator may influence the findings in this study, specifically in the psychomotor domain, because of a need to perceive the learners' progress. Driscoll (2000) supports the use of facilitator when teaching psychomotor skills via the web. Psychomotor learning, in some situations, requires coaching techniques, which means that the facilitator perhaps needs to hold the learner's hand to teach him/her, for instance, how to apply heat to the pad and the metal surface of a circuit board simultaneously for 4 seconds. Hoekman (1999) also supports the incorporation of psychomotor skill delivery on the web with other traditional methods of instruction; for example, combining facilitation techniques with soldering taught via the web.

Furthermore, the use of the Yes/No scale in the checklist form that was used for measuring psychomotor learning may have influenced the findings in this hypothesis. Raters in this experiment had to look only for whether or not a student performed a soldering step. If the student missed that step, the rater would check No; otherwise, the

rater would check Yes. As a result of using such instrument, there was no judgment of the quality of the performance of the psychomotor task because the scale of this instrument did not contain degrees of performance, such as the use of the Likert scale.

Last, hypothesis 4 stated that there would be no significant difference in levels of methods of instruction (WBI and traditional) on psychomotor learning across males and females. Because the p value ($p = .80$) was larger than the established level of significance ($\alpha = .05$), hypothesis 4 was retained. This means that no statistically significant interaction effects existed between the levels of methods of instruction (WBI and traditional-classroom instruction) and the levels of gender (male and female) on psychomotor learning. In other words, males' and females' performances do not change as a result of receiving psychomotor learning via the web or traditionally. This finding shows a conflicting view in relation to previous research studies, such as the study that was conducted by Proost, Elen, and Lowyck (1997). The results of their study indicated that women have a significantly more negative perception about computer-based technology and stronger preferences for traditional methods. Consequently, these results could be irrelevant to the nature of gender; rather, to experiences those women have passed through (Aldhafeeri, 2000). Therefore, the finding in this hypothesis may have been influenced by a smaller number of males as opposed to the number of females. Due to the smaller number of males than females, the results may not be applicable to similar experiments consisting of a larger number of males. The present study showed that males had a higher mean score ($\bar{M} = 12$) than females ($\bar{M} = 11.62$) when receiving instruction via the web. Perhaps, females did not prefer the given subject matter (soldering a circuit

board), which may have resulted in their lower performance. Perhaps the use of a series of psychomotor tasks from simple to more complex would reveal a different result with regard to this hypothesis. For example, if the subject matter were to consist of the following tasks: (a) identify components, (b) use resistor color code, (c) recognize polarity marks, (d) strip and tin wire, (e) mount components, (f) solder, (g) heat sink, and (h) desolder, the female learners would eventually score better. In addition, performing a psychomotor task repeatedly may show higher scores for the female group while the male scores would taper-off in terms of quality, precision, and speed.

The findings in this study may have been different if alternate circumstances existed. For example, retention of cognitive and psychomotor skills via the web may have been significantly higher than via traditional classroom instruction if the classroom environment were different. In this study, the participants in the web group were placed in a computer lab that did not have workstations designed specifically for performing hands-on tasks while receiving instruction. The participants in this group may have been distracted by the keyboard or perhaps by the mouse while soldering at the same time. Furthermore, the instructional design on the web may have greatly affected the findings in this study. The generous use of text in this study could have been replaced with diagrams, drawings, or animations. Such replacements may have enhanced learning via the web. Clay (1999) contends that overuse of text on the web decreases learning.

Conclusions

The conclusions drawn from this investigation must be viewed in light of the limitations imposed by the design of this experiment. Inferences and generalizations must

be limited to the experimental and control conditions unique to this investigation. Based on the findings of the study, the following conclusions were reached:

1. Adult learners who received traditional instruction achieved cognitive objectives as well as those who received instruction via the web. This conclusion is supported by the finding in this study and by a previous research study conducted by Driscoll (1998). She found that WBI is a suitable method for teaching in the cognitive domain.

2. Male adult learners and female adult learners perform equally in both cognitive and psychomotor learning when receiving instruction via the web or in a traditional manner. WBI has been shown to be a suitable method of instruction for both genders because it accommodates several adult-learning styles. The literature in chapter 2 revealed that adults adjust their learning styles to suit the web environment (Piskurich, 1993).

3. Using the web for delivering instruction on psychomotor learning, as opposed to cognitive learning, requires more preparation and understanding of instructional system design principles. WBI requires adequate instructional design to suit the nature of the given subject matter (Driscoll, 1998). For example, teaching a soldering task requires careful considerations regarding which media elements to include. Therefore, the instructional design can greatly affect learning; perhaps even more than the method of instruction variable: images are not as effective as video segments, which allow learners to perceive a complete motion of the motor skill.

4. Male adult learners and female adult learners perform equally in psychomotor learning when receiving instruction via the web or in a traditional way. French et al. (1999) also suggested that adult learning increases through instruction received via the web. In addition, WBI is an instructional medium that suits both types of gender. Male and female performance is not reduced as a result of receiving instruction via the web.

5. Specifically, the findings of this study appear to provide sufficient evidence to warrant the conclusion that WBI is an appropriate method of delivery, and it is able to deliver cognitive and psychomotor objectives, if adequate design was made. Previous studies showed that online learning programs are perceived equal to traditional methods of instruction. Findings in another study by Partow-Navid and Slusky (1999) indicate that teaching at distance is as effective as traditional instruction.

Recommendations for Further Study

Based upon the results of this study, several recommendations are suggested for future research in the area of WBI, instructional technology, instructional design and development, and classroom environments.

1. Although this study was limited to soldering a circuit board, generalizability and inferences cannot be applied to all areas of education and training. Therefore, similar studies should be undertaken concerning the effects of WBI on cognitive and psychomotor learning through simulations on the acquisitions of cognitive and psychomotor skills related to other areas in the fields of education and training. Some previous research has expressed general concern about conducting limited numbers of studies that measure learning outcomes as a result of using the web (Merisotis & Phipps,

1999; A. E. Barron & Orwig, 1997). In particular, Merisotis and Phipps (1999) has expressed the view that many research studies are limited to measuring the effects of specific types of learning, which is intended to inform or educate, not to build distinct skills. Therefore, conducting studies that measure the ability of an instructional intervention would help ensure the capability of that medium to deliver learning objectives, perhaps cognitive, psychomotor, or even affective-based objectives.

2. WBI provided cognitive and psychomotor objectives through simulation in teaching soldering skills not only enhanced learning in the experimental group but also proved to be cost-effective. However, additional research is required to evaluate the effects of WBI associated with longer treatment sessions. Future research may replicate this study by using a large time span or perhaps a full semester that involves both cognitive and psychomotor learning.

3. Because this study was limited only to volunteers in the ATTD program at the University of North Texas, future research in this area using subjects from different programs or educational or corporate settings should be considered. Favorable results from such research could provide valuable insight for improving the use of WBI in delivering training programs. In addition, replicating this study in another country, perhaps in the Middle East region, could expand, refine, or refute the applicability of the results found in this study.

4. To increase the level of interactions between instructor and students, further studies can add to the design of the experiment by incorporating live streaming video, especially in the teaching of psychomotor skills. The reason for use of such media

elements is based on the drawn conclusion in this study, which states that the use of text and pictures is not enough to support psychomotor learning. Because this study was limited to the use of one-media elements of synchronous systems, using interactive media elements other than Internet relay chat may produce more significant results. For example, future study can perhaps use live streaming video or audio to have a higher level of interaction between the instructor and the learners and among the learners themselves (Ashe & Buell, 1998). This recommendation was made based on what was revealed in the literature.

5. Based on the conclusion that the time of task completion affects learning when instruction is delivered via the web, future study may consider the time taken to deliver instruction as another independent variable. The present study was limited to only 30 minutes of instruction for both traditional and web groups. Because many organizations, such as businesses, seek to maximize efficiency in learning (McMasters, 1999), this variable should be researched in the near future.

6. This study opens the way for other researchers to examine the effect of web-based instruction/training programs on the cognitive and psychomotor domains of learning. This study was limited to measuring the effects of only two domain of learning, cognitive and psychomotor domain. The effect of web-based instruction/training on the affective domain of learning should also be examined in further studies.

7. This study could be replicated with consideration given to the interrater reliability coefficient among the judges. The research recommends the use of different methods of performance measure to evaluate learners' performance on a task that

involves psychomotor learning. In addition, potential researchers should consider conducting pilot testing to calculate the interrater reliability coefficient to ensure a high level of reliability among the raters and therefore obtain high level of accuracy about the learning level. Tests and instruments are being used regardless of their validity and reliability (Merisotis & Phipps, 1999).

8. This study may have revealed more surprising findings if the size of the population was larger. The population in this study was 50 students enrolled in courses in the ATTD program at the University of North Texas. As the size of the population increases, the sample size will also increase. Greater sample size would reveal more précised, powerful results (Hinkle et al., 1998). Therefore, the recommendation is to conduct studies similar to this study with a much larger sample size. This may result in a statistically significant finding in the psychomotor domain as discussed in the conclusions of this study.

9. Many assertions are suggested by the findings of this study and can be tested in future research. For example, does WBI support delivering all levels of cognitive and psychomotor learning? Some studies cited in this research mention that WBI can support only certain levels in learning domains. For example, Colbrunn and Tiem (2000) indicated that the first three levels in the cognitive domain (knowledge, comprehension, and application) can be delivered via the web, but they doubt the ability of the WBI programs easily to deliver the last three levels (analysis, syntheses, and evaluation). Therefore, future research studies should test this theory and provide guiding principles to make the web a good medium to support all levels of cognitive learning.

APPENDIXES

APPENDIX A
TABLE OF SAMPLE SIZE

Source: Krejcie and Morgan (1970)

Fig. 13-1*

A Sample Size Table for Proportions					
Degree of Accuracy = $\pm .05$		Proportion of Sample Size = 0.5		Confidence Level = 95%	
Population	Sample	Population	Sample	Population	Sample
10	9	230	144	1400	301
15	14	240	147	1500	305
20	19	250	151	1600	309
25	23	260	155	1700	313
30	27	270	158	1800	316
35	32	280	162	1900	319
40	36	290	165	2000	322
45	40	300	168	2200	327
50	44	320	174	2400	331
55	48	340	180	2600	334
60	52	360	186	2800	337
65	55	380	191	3000	340
70	59	400	196	3500	346
75	62	420	200	4000	350
80	66	440	205	4500	354
85	69	460	209	5000	356
90	73	480	213	6000	361
95	76	500	217	7000	364
100	79	550	226	8000	366
110	85	600	234	9000	368
120	91	650	241	10000	369
130	97	700	248	15000	374
140	102	750	254	20000	376
150	108	800	259	30000	379
160	113	850	264	40000	380
170	118	900	269	50000	381
180	122	950	273	60000	381
190	127	1000	277	70000	382
200	131	1100	284	120000	382
210	136	1200	291	160000	383
220	140	1300	296	1,000,000	383

*This table tells you the number of people you must survey to accurately represent the views of the population under study. Accurate here means reliable at the .005 reliability level. In other words, the chances of the results being funky is 5/100.

APPENDIX B

INSTITUTIONAL REVIEW BOARD APPROVAL

UNIVERSITY of NORTH TEXAS

Office of Research Services

March 28, 2000

Fayiz Alzafiri
1606 E. McKinney St., Apt. #2208
Denton, TX 76201

RE: Human Subjects Application No. 00-055

Dear Mr. Alzafiri,

Your proposal titled "An Experimental Investigation on the Effects of Web-based Instruction On Cognitive and Psychomotor Learning" has been approved by the Institutional Review Board and is exempt from further review under 45 CFR 46.101.

Enclosed is the consent document with stamped IRB approval. Please copy and use this form only for your study subjects.

The UNT IRB must re-review this project prior to any modifications you make in the approved project. Please contact me if you wish to make such changes or need additional information.

Sincerely,


Reata Busby, Chair
Institutional Review Board

RB:sb

APPENDIX C

RESEARCH CONSENT FORM

UNIVERSITY OF NORTH TEXAS
COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS
RESEARCH CONSENT FORM

Subject Name: _____ Date: _____

Title of Study: An Experimental Investigation on the Effects of Web-Based Instruction on Cognitive and Psychomotor Learning

Principal Investigator: Fayiz Alzafiri

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the proposed procedures. It describes the procedures, benefits, risks, discomforts of the study. It also describes your right to withdraw from the study at any time. It is important for you to understand that no guarantees or assurances can be made as to the results of the study.

PURPOSE OF THE STUDY AND HOW LONG IT WILL LAST:

The purpose of this study is to measure the effects of web-based instruction on cognitive and psychomotor learning. This study will examine the usefulness of using WBI in conducting cognitive and psychomotor training. The study will utilize the graduate and the undergraduate students (adult learners) in the Applied Technology, Training and Development program at the department of Technology and Cognition at the University of North Texas. The participants will receive a 40-minute instructional session in order to measure their ability to gain cognitive and psychomotor objectives. Two methods of instruction will be compared: web-based instruction and traditional methods of instruction. The participants will be divided into two groups: one group will receive instruction via the web while the other group will receive traditional instruction. The study will also investigate the effects of WBI on cognitive and psychomotor learning for both male and female students, who receive instruction via the web.

DESCRIPTION OF THE STUDY INCLUDING THE PROCEDURES TO BE USED:

The content subject of this experiment is "soldering." Each participant will receive a circuit board kit. This kit includes a safety glasses, solder, wire cutters, components, and a plastic circuit board that is not connected to any sort of electricity, it is just merely for practicing soldering. Afterward, the instructional treatments and a posttest, achievement and performance measures will be administered. This whole process takes about an hour and 30 minutes: 10 minutes are assigned for an introduction and signing in the Informed Consent Form, 40-minutes for instruction, and 40 minutes for the posttest. Furthermore, demographic data will be collected to help describe the sample in the study. Gender, age, major of study, and work experience are the demographic data that will be collected during the posttest period. Students' names are not necessary in this study.

APPROVED BY THE UNT IRB
FROM 3/26/00 TO 3/27/01
Ph

P. 1 of 4

UNIVERSITY OF NORTH TEXAS
COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS
RESEARCH CONSENT FORM

Subject Name: _____ Date: _____

Title of Study: An Experimental Investigation on the Effects of Web-Based Instruction on Cognitive and Psychomotor Learning

Principal Investigator: Fayiz Alzafiri

DESCRIPTION OF PROCEDURES/ELEMENTS THAT MAY RESULT IN DISCOMFORT OR INCONVENIENCE:


This research study involves no risk or violation of human rights. However, the instructional treatment of this study requires the subject to work with soldering a circuit board. This soldering technique requires the participants to use soldering iron. Soldering irons need to be used cautiously to avoid any sort of injuries such as burn. Another possible risk is injuring the eyes as a result of flying lead during the process of soldering. Therefore, the participant is asked to wear the safety glasses provided with the kit.

DESCRIPTION OF THE PROCEDURES/ELEMENTS THAT ARE ASSOCIATED WITH FORESEEABLE RISKS:

This research study has considered some precautions to protect the subjects from any unplanned discomfort. First, the researcher chooses not to use names of subjects to analyze the data; however, random coding system will be used instead. Second, the researcher chooses to provide both of the group in the study, the control and the experimental group, with safety tips to help them use the tools provided in the study appropriately and with no injury. Third, the researcher chooses to present the same instructional content for both groups in the study. Fourth, the instructional content used in this study is presented at an introductory level so that the subjects are not assumed to bring passed experience be being exposed to the experiment in this study.

BENEFITS TO THE SUBJECTS OR OTHERS:

The subject and other educational and training institutions will generate the benefits of this study. This study investigates a new trend, web-based instruction, in the fields of education and training. Combined research on how technology helps cognitive and psychomotor learning would assist organizations and educational institutions become aware of the level of achievement and performance of their learners during a course of instruction. Many managers in the corporate arena believe that WBI is the future of their training programs. Therefore, this study will reveal valuable results about

APPROVED BY THE UNT IRB
FROM 3/28/00 TO 3/27/01


P. 2 of 4

the effectiveness of Web-Based Instruction (WBI) on the cognitive and psychomotor domains of learning.

CONFIDENTIALITY OF RESEARCH RECORDS:

All information obtained from this experiment will be confidential and will not be used outside of this study. The results of both the cognitive test and the psychomotor test will be used only to compare the performance of the subjects in the different methods of instruction used in this research. Subjects' names will not be used to analyze the data. Indeed, the researcher decides to use a coding system, which will randomly assign numbers for the subjects and use these numbers during the analysis process. This means that even the researcher of this study cannot identify the specific result for a specific subject.

APPROVED BY THE UNT IRB
FROM 3/28/00 TO 3/27/01
(Signature)

P. 3 of 4

UNIVERSITY OF NORTH TEXAS
COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS
RESEARCH CONSENT FORM

Subject Name: _____ Date: _____

Title of Study: An experimental Investigation on the Effects of Web-Based Instruction on Cognitive and Psychomotor Learning

Principal Investigator: Fayiz Alzafiri

REVIEW FOR PROTECTION OF PARTICIPANTS:

This research study has been reviewed and approved by the UNT Committee for the Protection of Human Subjects (940) 565-3940.

RESEARCH SUBJECTS' RIGHTS: I have read or have had read to me all of the above.

Fayiz Alzafiri has explained the study to me and answered all of my questions. I have been told the risks or discomforts and possible benefits of the study.

I understand that I do not have to take part in this study, and my refusal to participate will involve no penalty or loss of rights to which I am entitled. I may withdraw at any time without penalty or loss of benefits to which I am entitled. The study personnel can stop my participation at any time if it appears to be harmful to me, if I fail to follow directions for participation in the study, if it is discovered that I do not meet the study requirements, or if the study is canceled.

In case there are problems or questions, I have been told I can call Fayiz Alzafiri at telephone number (940) 591-0002, or Dr. Jerry Wircenski at 565-2714.

I understand my rights as a research subject, and I voluntarily consent to participate in this study. I understand what the study is about and how and why it is being done. I will receive a signed copy of this consent form.

Subject's Signature

Date

Signature of Witness

Date

For the Investigator or Designee:

I certify that I have reviewed the contents of this form with the person signing above, who, in my opinion, understood the explanation. I have explained the known benefits and risks of the research.

Principal Investigator's Signature

Date

APPROVED BY THE UNT IRB
FROM 03/28/01 TO 03/27/01
(Signature)

P. 4 of 4

APPENDIX D

SAMPLE SIZE REQUIREMENTS

TABLE C.12
Sample Sizes for Varying Numbers of Treatment Levels and Effect Sizes to be Detected

		Sample size per treatment level with differences to be detected between treatment levels ($C\sigma$) of:				
		.5 σ	.75 σ	1.0 σ	1.25 σ	1.5 σ
		$\alpha = .05$				
Power = .75	Number of treatment levels (k)					
	2	55	26	15	10	7
	3	69	31	18	12	9
	4	79	35	21	14	10
	5	88	39	23	15	10
	6	95	42	24	16	11
	7	101	45	26	17	11
	8	107	48	27	18	12
		$\alpha = .01$				
	2	85	39	23	15	11
	3	103	46	27	18	13
	4	117	53	30	20	14
	5	130	58	33	21	15
	6	137	61	35	22	16
	7	143	64	37	23	17
	8	148	66	38	24	18
		$\alpha = .05$				
Power = .80	2	62	29	17	12	8
	3	78	35	20	14	10
	4	88	40	23	16	11
	5	96	43	25	17	12
	6	103	47	27	18	13
	7	110	50	29	19	13
	8	117	52	30	20	14
		$\alpha = .01$				
	2	93	43	25	17	12
	3	112	52	29	20	14
	4	124	56	32	22	16
	5	134	60	34	23	17
	6	144	64	36	25	18
	7	150	68	38	26	19
	8	156	71	40	27	19

Source: From D. E. Hinkle, J. D. Oliver, and C. A. Hinkle, "How Large Should the Sample Part Be? A Question with No Simple Answer? Or . . ." *Educational and Psychological Measurement*, 43 (1983), pp. 1051-1060. Copyright ©1983. Reprinted by permission of Sage Publications, Inc.

APPENDIX E

TRADITIONAL CLASSROOM INSTRUCTION MATERIALS

The instructional materials of this course can be requested from Chaney Electronic Incorporation.



Transparency Set 5 (TPS5): Learn to Solder

Objective:

The objective of this transparency presentation is to teach the student about the soldering process: the basic tools, steps to solder, and how to recognize good and bad soldering joints.

Materials Needed:

- Transparency (overhead) projector.
- Transparencies TPS5-1a to TPS5-3
- Script for TPS5
- Test for TPS5 which consists of TestTPS5-A and TestTPS5-B, two slightly different versions of the same test. You need a copy of either test per student. Note: The tests are copyrighted but the instructors are allowed to make copies of them.
- Answer sheets for tests: TestTPS5-A and TestTPS5-B.

APPENDIX F

WEB-BASED INSTRUCTOIN MATERIALS

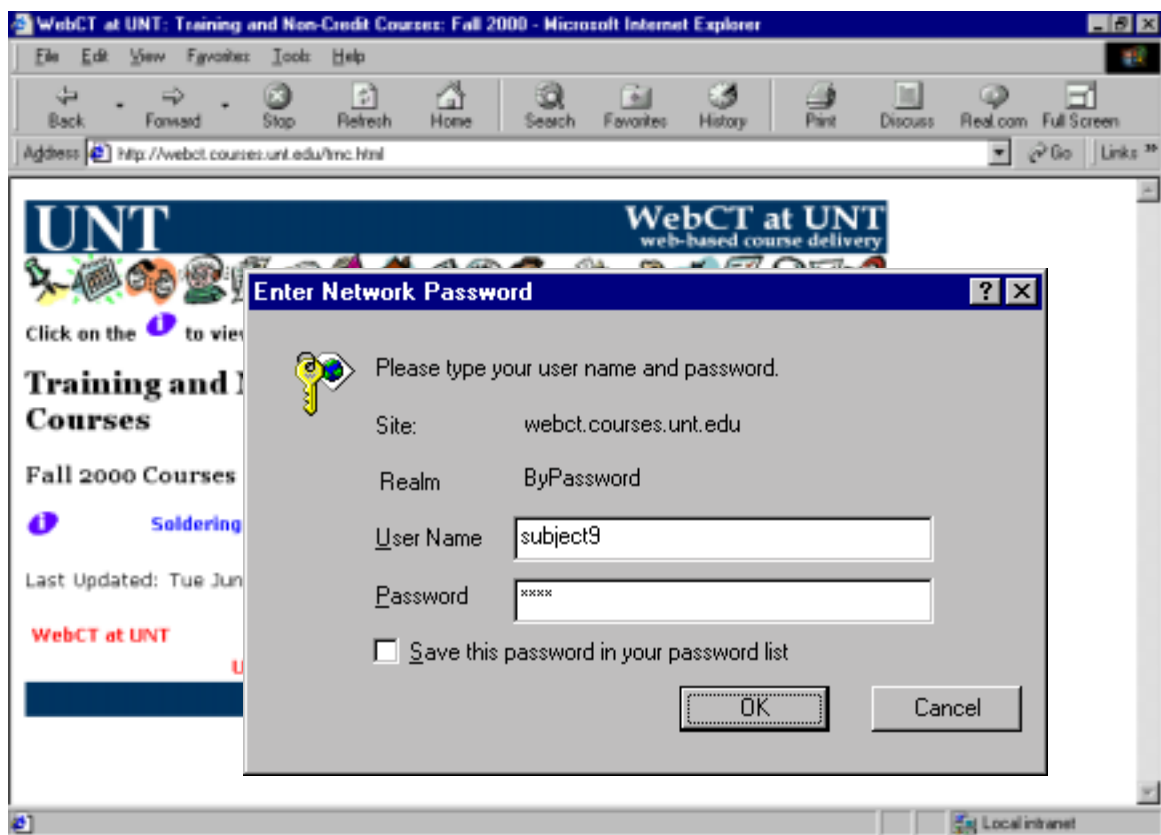
Instruction Sheet

1. Go to the Netscape browser and type in the following URL to access your *Soldering Techniques* session:
<http://webct.courses.unt.edu/trnc.html>
2. Click on [Soldering Techniques](#) link to access the instructional session.
3. When it asks you about your user name and password, type in the following:
 - Your user name is the word **subject** followed by your code
 - Your password is: **attd**
4. After you have accessed the course (HOME PAGE), you will see three main topics or icons: Syllabus, Course Content, and Class Communications. Click on the [Syllabus](#) to read the course objectives.
5. When finished reading the syllabus, go ahead and close the syllabus page. At the home page, click on [Course Content](#).
6. On the [Course Content](#) page, you have all the subtopics that you should go through to learn the soldering task. Click on the [Overview](#) link to access the content of the course, and start from there.
7. Remember you can always ask for assistant if you get stuck, and also remember that you can chat with your instructor at anytime during the session, especially if you have question about the skill you are learning.
8. Whenever you go to the Chat Rooms, choose the one stating “General Chat for FALZAFIRI”
9. At this point, all class members and instructor will be able to direct the learning process.

Good Luck ☺

Web-Based Instruction Soldering Techniques Course

<http://webct.courses.unt.edu/trnc.html>



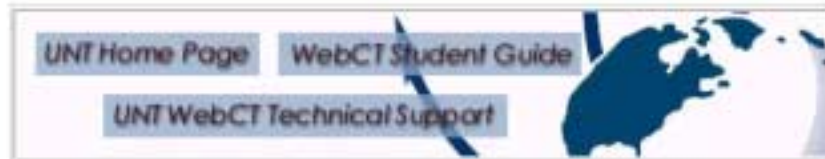
Main Page (Home)

Soldering Task

Syllabus		Course Content		Class Communications	
--------------------------	---	--------------------------------	---	--------------------------------------	---

WebCT at UNT [Student Guide](#) Support questions to: webct@unt.edu

University of North Texas



Syllabus Page

Close Back Forward

Syllabus

Course Title: **Soldering Techniques**

General Course Objective:


This short course intends to provide the learner with knowledge and techniques to perform soldering.

Specific Course Objectives:

By the end of this short course, the participants shall be able to:

1. Identify the basic tools used in soldering process.
2. Identify the steps to solder.
3. Recognize good and bad soldering joints.
4. Perform soldering using a practice circuit board

Instructor:



Brian Urban

Mr. Urban is a lab manager in the department of Engineering Technology at the University of North Texas. During this course, he will have a live communication with the learners through a **chat room**.

Audience:

This course is designed for graduate and undergraduate students in the Applied Technology, Training and Development Program (ATTD) in the College of Educating at the University of North Texas. The ATTD students are considered the target population for this course, by which an experimental study will be able to determine the effects of web-based instruction method to deliver cognitive and psychomotor objectives.

Further Information:

Please contact Fayiz Alzafri
Technology and Cognition Department
Applied Technology, Training and Development Program (ATTD)
Email: fayiz@unt.edu

Soldering Techniques

- 1. Overview
- ▼ 2. Soldering Steps
 - 2.1. Step 1
 - 2.2. Step 2
 - 2.3. Step 3
 - 2.4. Step 4
 - 2.5. Step 5
 - 2.6. Step 6
 - 2.7. Step 7
 - 2.8. Step 8
 - 2.9. Step 9
 - 2.10. Step 10
- ▼ 3. Soldering Quality
 - 3.1. Good Solder Joint
 - 3.2. Cold Solder Joint
 - 3.3. Solder Not Attached to Lead
 - 3.4. Solder Not Attached to Pad
 - 3.5. Leads Not Trimmed
 - 3.6. Solder Bridge
- 4. Review

[\[Home\]](#)

Overview

- Today, we are going to start our session by identifying the basic tools used in soldering using the soldering kit in front of you.



This soldering kit contains:

1. Damp Sponge;
2. Wire Cutters;
3. Safety Glasses;
4. Soldering Iron;
5. Resistors (Components);
6. Circuit Board; and
7. Solder.

- The following video clip identifies the basic tools used in soldering:



Click on the image to view the soldering video clip.



If you have any question during this session, don't forget to click on the chat icon above to interact with the instructor and other classmates.



Go Forward

Soldering Steps

There are 10 steps for soldering a circuit board:

1. Prepare the Component
2. Mount the Component
3. Bend the Leads of the Component
4. Clean Iron's Tip
5. Apply the Heat (Soldering Iron)
6. Apply the Solder
7. Remove the Solder
8. Remove the Iron
9. Inspect the Work
10. Trim the Leads

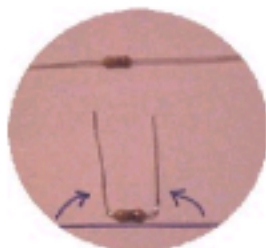


Backward



Forward

Soldering Step 1



Step 1: Prepare component for mounting.

In this step you bend the leads of the component at 90 degree angle to fit into the holes of the circuit board. You can do this with your hand. Be sure that the leads are bent at the right distance from the body of the component so they fit comfortably in the holes on the board.

The following video clip illustrates the **first three steps** for soldering:



Click on the image to view the soldering video clip.



Go ahead and practice this step using your soldering kit.

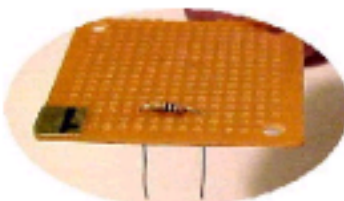


Backward



Forward

Soldering Step 2



Step 2: Mount component on board.

In this step you insert the leads of the component into the holes on the board, from the component side. The body of the component should rest on the component side of the board. It is a common incorrect practice among new students to install the component on the soldering side (oil side) of the board instead of the component side, or to install the component away from the surface of the board, instead of resting on the surface of the board, as shown in the figure.



Go ahead and practice this step using your soldering kit.

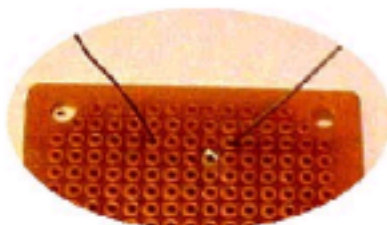


Backward



Forward

Soldering Step 3



Step 3: Bend component leads slightly.

After you have inserted the leads of the component into the holes on the board, you should bend the component leads slightly to hold the component in place while the board is turned over to be soldered.



Go ahead and practice this step using your soldering kit.



Backward



Forward

Soldering Step 4



Step 4: Clean iron's tip.

Before you start soldering and after the tip of the iron has heated up, the tip of the iron should be cleaned on a damp sponge and tinned, by melting a piece of solder on the iron's tip and then wiping the tip on the damp sponge again. The tip of the iron should always have an even shiny metal surface from the solder. Each time oxide forms on the tip, clean the tip on damp sponge to make it shiny again.

 The following video clip illustrates the **next five steps** for soldering.



Click on the image to view this soldering video clip.



Go ahead and practice this step using your soldering kit.

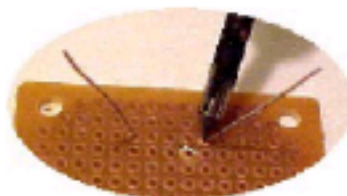


Backward



Forward

Soldering Step 5



Step 5: Apply heat

In this step you apply heat to the joint to be soldered by touching the tip of the iron firmly against both the component lead, and the pad on the board, simultaneously. Allow about three seconds or more for the joint to heat up before applying the solder. This is one of the most important steps in the soldering process. If you do not heat up the joint (lead and pad on the board) sufficiently you will get a cold soldering joint which will have to be resoldered.



Go ahead and practice this step using your soldering kit.

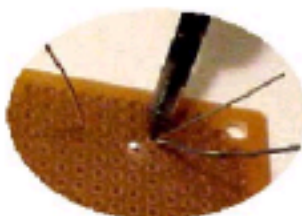


Backward



Forward

Soldering Step 6



Step 6: Apply solder.

After the joint has heated up, apply solder to the point where the lead and the pad join. Apply enough solder to create a "mountain" of solder that attaches to both, the lead and the pad, as shown in the drawing of step 6. A common problem among new students is to apply too little or too much solder, neither is good.



Go ahead and practice this step using your soldering kit.

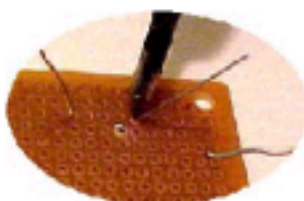


Backward



Forward

Soldering Step 7



Step 7. Remove solder.

After the solder has melted on the joint forming a nice connection as the one shown in step 8 and 9, remove the solder wire from the joint.



Go ahead and practice this step using your soldering kit.

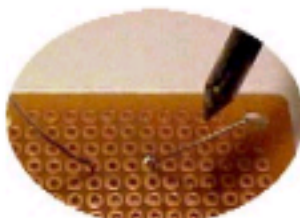


Backward



Forward

Soldering Step 8



Step 8: Remove iron.

After the solder wire has been removed, remove the iron from the joint.



Go ahead and practice this step using your soldering kit.

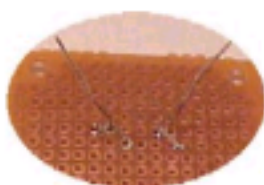


Backward



Forward

Soldering Step 9



Step 9: Inspect the soldering joint.

After the joint has cooled off, visually inspect the joint that you have created. It should have a shiny and smooth surface and it should attach to both the component lead, and the pad on the board.

- The following video clip illustrates the **last two steps** in soldering:



Click on the image to view the soldering video clip.



Go ahead and practice this step using your soldering kit.



Backward



Forward

Soldering Step 10



Step 10: Cut off component leads.

After you have soldered a joint the next step is to cut off the excess component lead using a wire cutter. Trim the lead of the component as close to the solder joint as possible. This is another important step in the assembly process that can not be avoided because untinned component leads might cause short circuits between metallic traces on the board.



Go ahead and practice this step using your soldering kit.



Backward



Forward

 home	 contents
 previous	 refresh
 pg back	 pg fwd

 glossary	 chat
--	--

Soldering Quality

• Six points determine the quality of your soldering skill:

- Good Solder Joint
- Cold Solder Joint
- Solder Not Attached to Lead
- Solder Not Attached to Pad
- Leads Not Trimmed
- Solder Bridge

Click on each of the above links to have more discussion about each point, or you can use the forward button to learn about them in a sequential order.



Backward



Forward



Good Solder Joint

"Picture is purposely omitted"

As we have said before, a good soldering joint has a shiny and smooth surface and attaches to both the component lead, and the pad on the board.



Backward



Forward



Cold Solder Joint

Picture is purposely omitted"

You can recognize a cold solder joint because it is dull (not shiny) and irregular (not smooth). Cold solder joints do not make good electrical connections and should be resoldered.



Backward



Forward



Solder Not Attached to Lead

Picture is purposely omitted"

In this type of defective soldering joint the solder is attached to the pad of the board but not to the lead of the component. In some cases, this is very obvious to see, but in other cases it might not be, as in the case shown on the right side view. Only a careful inspection of the joint will detect this problem, because you will see that even when the solder is surrounding the component lead, it does not attach to it. If in doubt, always resolder the joint.



Backward



Forward



Solder Not Attached to Pad

Picture is purposely omitted"

In this type of defective soldering joint the solder is attached to the lead of the component but not to the pad on the board. In some cases this is very obvious and easy to detect but in other cases it is not and only a careful inspection of the joint will detect this problem. In these cases you will see that even if the solder appears to be resting upon the pad, it's not attached to it and there is a layer of rosin between the pad and the solder. If in doubt, always resolder the joint.



Backward



Forward

Leads Not Trimmed

Picture is purposely omitted

This problem is caused by not tinning the component leads after soldering the joint. Leads that are not tinned pose a potential problem because they can be touching each other or touching other parts of the pad, producing short circuits and damaging the components. Never leave untinned leads after the soldering is completed.



Backward



Forward

Solder Bridge

Picture is purposely omitted

A solder bridge is a bridge made with solder that is connecting two pads (or foil traces) that should not be connected. Sometimes solder bridges are easy to detect and other times they are so tiny that they can only be detected with the use of a magnifying glass. Solder bridges can be eliminated by melting them with the soldering iron.



Backward



Forward

 home	 contents
 retrace	 refresh
 pg back	 pg fwd

 glossary	 chat
--	--

Review

- The following video clip provides a quick review for performing soldering.



Click on the image to view the soldering video clip.



Please click on the chat icon above to review what we learned in this session.



You have reached the end of the course content.



Backward

Class Communication (Online Chat)

Course Communications:

- E-mail-- to send mail to your classmates or professor inside WebCT
- Web Conference-- allow for discussions about class topics
- Chat-- Talk/Type to your classmates or your professor in real-time!



[Online Chat](#)

WebCT at UNT [Student Guide](#)

Support questions to: webct@unt.edu

[\[Home\]](#)

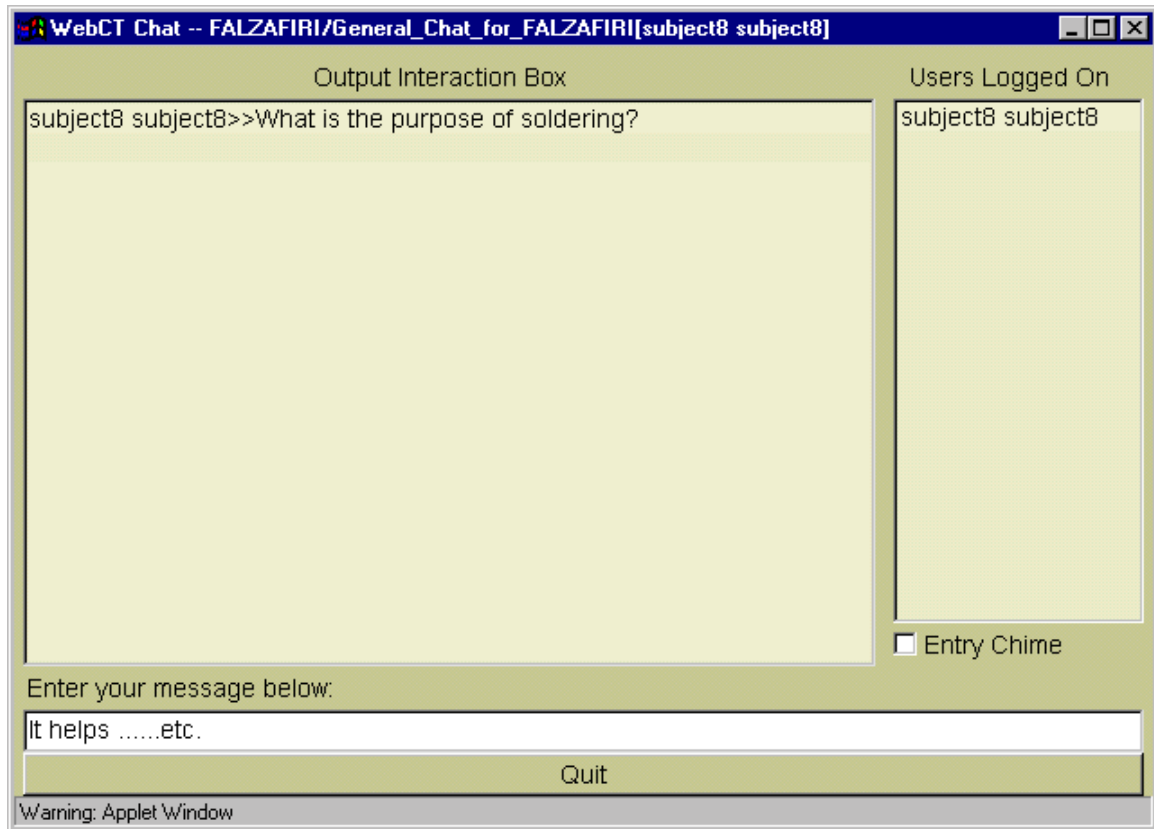


Welcome to WebCT Chat.
Click on a room to enter it.

[Home](#) [Back](#)

Group 1	Group 2	Group 3	Group 4
General Chat for FALZAFIRI			
General Chat for All Courses			

Note: Conversations in the following rooms will be recorded: Group 1, Group 2, Group 3, Group 4.



APPENDIX G
INSTRUCTOR'S RESUME

BRIAN L. URBAN

3056 Lakeshore Blvd. • The Colony, TX 75056 • 972-625-1680

QUALIFICATIONS

- Over 20 years relevant work experience in various aspects of the engineering profession.
- Experience in equipment maintenance including computer hardware and software installation.
- Experienced in using circuit board design software from multiple vendors.
- Experience with circuit board design.

EMPLOYMENT

UNIVERSITY OF NORTH TEXAS DEPARTMENT OF ENGINEERING TECHNOLOGY

Lab Management Technician, 1998-Present

Responsible for maintaining all labs and lab equipment within the Department of Engineering Technology. Maintain 100 workstation LAN including server, hubs, cable plant, and workstations. Develop upgrade plans and schedules for LAN and workstations. Supervise two student workers. Coordinate all building maintenance with University.

COLLIN COUNTY COMMUNITY COLLEGE

Lab Technician, Part-Time Instructor, 1995-1998

Maintain lab equipment including oscilloscopes, function generators, spectrum analyzers, telephone switch, and other equipment. Maintain 36 lab computers including installation of new software, memory, hard drives and other repairs as necessary. Order lab supplies and parts necessary for student experiments. Coordinate student assistant coverage of open lab hours. Teach sections of Electronic Technology courses. Use computer software to design printed circuit boards for use in laboratory projects.

BRIAN URBAN CONTRACT SERVICES

Consultant, 1987-1995

Provide broadcast technical consulting services including performing AM, FM and TV allocation studies, preparation of engineering reports, applications, petitions, and other documents for filing with the FCC and FAA. Specify, design and install equipment in all types of broadcast facilities (AM, FM, TV, Shortwave studios and transmitters). Have received numerous application grants from the FCC.

TELELINK, INC.

Satellite Uplink Operator, 1984-1986

Operated and maintained three C-band transportable uplinks (nationwide and internationally), maintained three camera production truck. Worked with field production staff, both technical and non-technical to establish signal paths and maintain signal quality during transmission.

TECHNOR MEDIA SYSTEM

Operator and Studio Technician, 1973-1984

Operated 50KW AM transmitter site. Operated combined TV/FM transmitter site as emergency relief. Studio technician for combined AM/FM/TV studio operations.

Maintained studio equipment including microwave links, routing systems, cameras, VTRs, and switchers.

EDUCATION

UNIVERSITY OF NORTH TEXAS

B.S., Electronic Engineering Technology

Expected graduation May, 2000.

COLLIN COUNTY COMMUNITY COLLEGE

A.S., Electrical Engineering Technology, 1996

Graduated with honors, 3.69 GPA.

LICENSES

- General Class Radiotelephone, License #PG-9-3654 (Lifetime Permit)
- Society of Broadcast Engineers, Certified Broadcast Technologist, Certificate #20456

APPENDIX H

TEACHING AGREEMENT AND CONDITIONS

Agreement and Conditions to Teach in a Research Study

Title of Investigation: An experimental Investigation on the Effects of Web-Based Instruction on Cognitive and Psychomotor Learning

Principle Investigator: Fayiz Alzafiri

This is to certify that I, Brian L. Urban, hereby agree to participate as an instructor in a study as authorized part of the education and research program of the University of North Texas under the supervision of Fayiz Alzafiri.

An explanation of the study has been described to me including the procedures to be followed. I have had an opportunity to ask questions about my participation, and all questions and inquiries have been answered to my satisfaction. Therefore, I certify that I have no preference or bias to any of the groups that I will be teaching during the study. I will teach all the groups/subjects involved this study as equally and enthusiastically as I can.

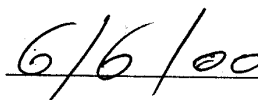
I have been assured that any information received in this study will remain anonymous and confidential, and shall not be shared with any outside party by any means.

I understand that I am free to withdraw my consent and to discontinue participation in the project at any time without penalty, prejudice, or loss of benefits.

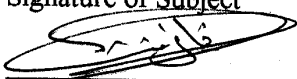
I have read and understood the explanation provided to me and voluntarily agree to participate in this study.



Signature of Subject



Date



Principle Investigator's Signature

For further information, contact:
Fayiz Alzafiri (fayiz@unt.edu)
1606 East McKinney #2208
Denton, TX 76201
(Telephone: 940-591-0002)

APPENDIX I

MEMO FOR INSTRUCTORS IN THE ATTD PROGRAM

MEMO

DATE: 04/27/2000

TO: ATTD INSTRUCTORS (ATTD 4000/5000.001, ATTD 4300.001, ATTD 4470/5470.001, ATTD 4630/5630.001,, ATTD 4340.001, ATTD 4350.001, ATTD 4450/5450.001, ATTD 4460.001, ATTD 4070.001, ATTD 4520.001, ATTD 5530.001, ATTD 6100.001)

FROM: DR. JERRY WIRCENSKI

RE: PARTICIPATING IN AN EXPERIMENTAL STUDY

I would like to ask for your cooperation and participation in an experimental study in the summer 2000 that will be conducted by Fayiz Alzafiri, a doctoral candidate in the ATTD program, in the **week of 12 of June**. The title of the study is "An Experimental Investigation on the Effects of Web-Based Instruction on Cognitive and Psychomotor Learning".

The nature of the experiment requires the cooperation of the instructors in the ATTD program to volunteer their classes to work with soldering a circuit board. This task involves cognitive and psychomotor learning. The students will be provided with a soldering kit to work with all necessary materials to complete the activity. The time required to deliver this task is approximately one hour.

Upon your agreement to participate in this experiment, Mr. Fayiz Alzafiri will contact you to discuss and inform you about the placement of your class in either the control group or the experimental group. The control group involves traditional-classroom instruction. The experimental group involves web-based instruction.

Please fill out the bottom part of this memo and return to me.

Your cooperation and participation in this experimental study is highly appreciated.

Sincerely,
Dr. Jerry Wircenski

☐

YES, I WANT TO VOLUNTEER MY SUMMER CLASS TIME FOR THE STUDY.

MY CLASS NUMBER IS ATTD

THE BEST VOLUNTEER TIME FOR MY CLASS (FROM 12-16 OF JUNE) IS ON (DAY)

AT (TIME TO START)

☐

NO, I DO NOT WANT TO VOLUNTEER MY CLASS TIME FOR THE STUDY.

APPENDIX J

KNOWLEDGE-BASED TEST

The knowledge test used in this study can be purchased from Chaney Electronics Incorporation.



Transparency Set 5 (TPS5): Learn to Solder

Objective:

The objective of this transparency presentation is to teach the student about the soldering process: the basic tools, steps to solder, and how to recognize good and bad soldering joints.

Materials Needed:

- Transparency (overhead) projector.
- Transparencies TPS5-1a to TPS5-3
- Script for TPS5
- Test for TPS5 which consists of TestTPS5-A and TestTPS5-B, two slightly different versions of the same test. You need a copy of either test per student. Note: The tests are copyrighted but the instructors are allowed to make copies of them.
- Answer sheets for tests: TestTPS5-A and TestTPS5-B.

APPENDIX K
SOLDERING CHECKLIST FORM

Soldering Checklist Form

Part A (Process Assessment)

Directions: Observe student performance while soldering. Check (YES) if the student performed the step, check (NO) if the student did not perform the step as described.

ITEM	YES	NO
1. Did the student bend the leads of the component at or close to 90-degree angle?	Yes	No
2. Did the student mount the component correctly?	Yes	No
3. Did the student bend the leads slightly after mounting?	Yes	No
4. Did the student clean the iron's tip correctly?	Yes	No
5. Did the student apply the heat to the lead and the pad simultaneously for at least 3 seconds?	Yes	No
6. Did the student apply solder after applying the heat to fill the joint?	Yes	No
7. Did the student remove solder ?	Yes	No
8. Did the student remove iron after removing the solder?	Yes	No
9. Did the student inspect solder ?	Yes	No
10. Did the student cut the lead as close to the solder joint as possible?	Yes	No

Part B (Product Assessment)

Directions: While observing each circuit board turned in by the students, check (**YES**) if you agree with the corresponding item, check (**NO**) if the you do not agree with the corresponding item.

ITEM	YES		NO	
11. There is a good solder joint .	<input type="checkbox"/>	Yes	<input type="checkbox"/>	No
12. The solder is attached to lead .	<input type="checkbox"/>	Yes	<input type="checkbox"/>	No
13. The solder is attached to pad .	<input type="checkbox"/>	Yes	<input type="checkbox"/>	No
14. The leads are trimmed .	<input type="checkbox"/>	Yes	<input type="checkbox"/>	No
15. There is no a solder bridge .	<input type="checkbox"/>	Yes	<input type="checkbox"/>	No

APPENDIX L
DEMOGRAPHIC DATA COLLECTION FORM

Subject Code # _____

Directions: Please check the appropriate box for each of the following items. Item 4 requires you to write out the answer.

1. Gender:

Male
Female

2. Age:

Less than 18
18-25
26-35
36-45
More than 45

3. Educational Level:

Graduate
Undergraduate

4. Major of Study:

5. Have you had an experience with *soldering a circuit board* in the past?

Yes
No

6. If yes, when was the last time you worked with *soldering a circuit board*?

Less than a year
1-3 years ago
4-5 years ago
More than five years ago

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study. The analysis was run for each of the dependent variables, cognitive and psychomotor learning.

Although there was not a statistically significant difference in the main effects of method of instruction or interaction effects between method and gender, the results imply that students in the traditional-classroom instruction group performed better than those in the WBI group in psychomotor learning. Perhaps, this trend would be statistically significant if the sample size were larger. This study provides empirical evidence for the effectiveness of WBI in delivering cognitive and psychomotor objectives. The outcome of this study supports the need for more research on the effects of WBI on learning domains.